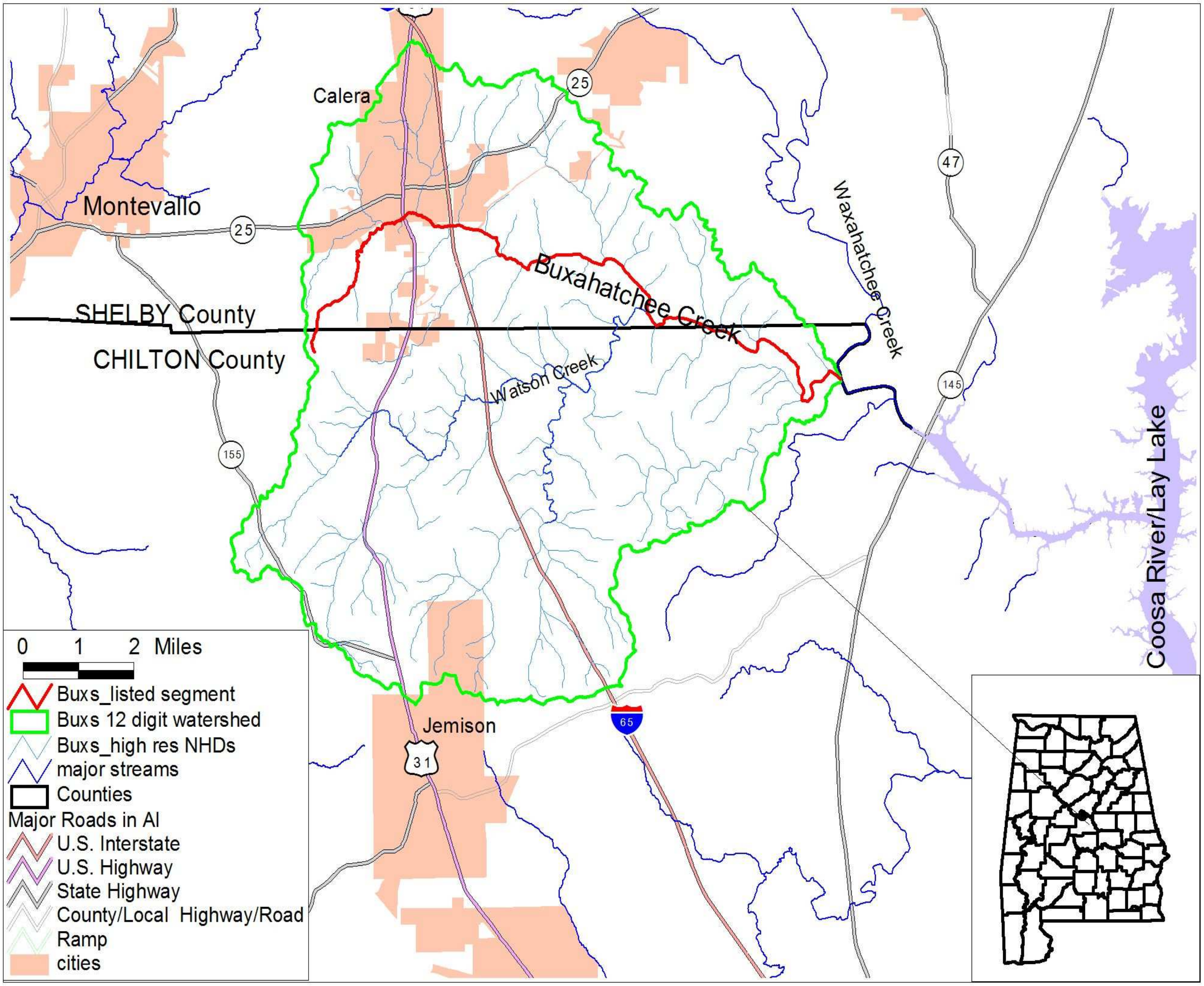
Alabama Department of Environmental Management

FINAL
Total Maximum Daily Load
Nutrients

Buxahatchee Creek
AL03150107-0502-100
Nutrients

Alabama Department of Environmental Management
Water Quality Branch
Water Division
March 2008

Figure 1.1: Map of Buxahatchee Creek Watershed



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1.0 Executive Summary

The Alabama Department of Environmental Management (ADEM) has identified Buxahatchee Creek of the Lower Coosa River basin as being impaired for nutrients. Buxahatchee Creek, a tributary to Waxahatchee Creek, which eventually discharges to Lay Lake of the Coosa River, was originally listed on Alabama's 303(d) list in 1992, 1994, and 1996 for nutrients and organic enrichment/dissolved oxygen (OE/DO). The basis for the original listing is based on data provided by ADEM's 1988 and 1991 Clean Water Strategy (CWS) Reports. In 1996, ADEM completed a Total Maximum Daily Load (TMDL) which addressed the organic enrichment/dissolved oxygen impairment within Buxahatchee Creek and this OE/DO TMDL was approved by the Environmental Protection Agency (EPA) in 1997. Therefore, Buxahatchee Creek remains on the 1998, 2000, 2002, 2004, and 2006 303(d) lists for nutrients. This report will address the nutrient impairment within Buxahatchee Creek. A map of the Buxahatchee Creek watershed can be found in Figure 1.1. 303(d) listing details for Buxahatchee Creek are shown below:

Waterbody ID	Waterbody Name	Counties	Uses	Causes	Sources	Size	Support Status
AL/03150107-0502-100	Buxahatchee Creek	Shelby and Chilton	Fish and Wildlife (F&W)	Nutrients	Municipal and Urban Run-off	14 miles	Non

The pollutant of concern for the impaired segment is nutrients. Nutrients are of concern due to their ability to promote algal growth, which in turn affects the dissolved oxygen balance through photosynthesis, respiration, and the regeneration of organic materials. Normally, ADEM would target only total phosphorus (TP) as the nutrient of concern for a stream that is effluent-dominated such as Buxahatchee Creek. However, since Buxahatchee Creek drains into an embayment of Lay Lake of the Coosa River, which is considered impaired for nutrients, ADEM will also target total nitrogen (TN).

Establishing TP and TN targets that fully support the designated uses of Buxahatchee Creek is part of the lengthy and complex process of TMDL development. The nutrient targets were developed using a "reference condition" approach using data from eco-region 45(a), Southern Inner Piedmont, and taking the 90th percentile of this data to calculate the target concentrations. The TP and TN target concentrations for Buxahatchee Creek are 0.048 mg/L and 0.298 mg/L, respectively.

The TMDL results for the Buxahatchee Creek Nutrient TMDL are shown below:

	Existing loads		Allowable loads		Reductions	
Polluant	**WLA**	**LA**	**WLA**	**LA**	**WLA***	**LA**
TP (lbs/day)	17.36	0.24	0.60	0.32	97%	N/A
TN (lbs/day)	19.25	2.29	3.73	1.45	81%	37%

*The Percent Reduction based on current permit limits for TP would equate to 92 %

TMDL = WLA + LA + MOS*			
Polluant	**TMDL**	**WLA**	**LA**
TP (lbs/day)	0.92	0.60	0.32
TN (lbs/day)	5.17	3.73	1.45

*** implicit MOS**

2.0 Basis for §303(d) Listing

2.1 Introduction

Section 303(d) of the Clean Water Act (CWA), as amended by the Water Quality Act of 1987, and EPA's Water Quality Planning and Management Regulations [(Title 40 of the Code of Federal Regulations (CFR), Part 130)] require states to identify waterbodies which are not meeting water quality standards applicable to their designated uses and to determine the total maximum daily load (TMDL) for pollutants causing use impairment. The TMDL process establishes the allowable loading of pollutants for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water-quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The Alabama Department of Environmental Management (ADEM) has identified Buxahatchee Creek of the Lower Coosa River basin as being impaired for nutrients. Buxahatchee Creek, a tributary to Waxahatchee Creek, which eventually discharges to Lay Lake of the Coosa River, was originally listed on Alabama's 303(d) list in 1992, 1994, and 1996 for nutrients and organic enrichment/dissolved oxygen (OE/DO). The basis for the original listing is based on data provided by ADEM's 1988 and 1991 Clean Water Strategy (CWS) Reports. In 1996, ADEM completed a Total Maximum Daily Load (TMDL) which addressed the organic enrichment/dissolved oxygen impairment within Buxahatchee Creek and this OE/DO TMDL was approved by the Environmental Protection Agency (EPA) in 1997. Therefore, Buxahatchee Creek remains on the 1998, 2000, 2002, 2004, and 2006 303(d) lists for nutrients. This report will address the nutrient impairment within Buxahatchee Creek.

2.2 Problem Definition

Waterbody Impaired:	Buxahatchee Creek from Waxahatchee Creek to its source.
Waterbody length:	14 miles
Waterbody drainage area:	70 square miles
Water Quality Standard Violation:	Narrative criteria (nutrients)
Pollutants of Concern:	Total Phosphorus and Total Nitrogen
Water Use Classification:	Fish and Wildlife

Usage of waters in the Fish and Wildlife category is described as follows in ADEM Admin. Code R. 335-6-10-.09(5) (a), (b), (c), and (d):

(a) Best usage of waters: fishing, propagation of fish, aquatic life, and wildlife, and any other usage except for swimming and water-contact sports or as a source of water supply for drinking or food-processing purposes.

(b) Conditions related to best usage: the waters will be suitable for fish, aquatic life and wildlife propagation. The quality of salt and estuarine waters to which this classification is assigned will also be suitable for the propagation of shrimp and crabs.

(c) Other usage of waters: it is recognized that the waters may be used for incidental water contact and recreation during June through September, except that water contact is strongly discouraged in the vicinity of discharges or other conditions beyond the control of the Department or the Alabama Department of Public Health.

(d) Conditions related to other usage: the waters, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming places and will be considered satisfactory for swimming and other whole body water-contact sports.

2.3 Water Quality Criteria

ADEM’s decision to list Buxahatchee Creek as being impaired for nutrients was authorized under ADEM’s Water Quality Standards Program, which employs both numeric and narrative criteria to ensure adequate protection of designated uses for surface waters of the State. Numeric criteria typically have quantifiable endpoints for given parameters such as pH, dissolved oxygen, or a toxic pollutant, whereas narrative criteria are qualitative statements that establish a set of desired conditions for all State waters. These narrative criteria are more commonly referred to as “free from” criteria that enable States a regulatory avenue to address pollutants or problems that may be causing or contributing to a use impairment that otherwise cannot be evaluated against any numeric criteria. Typical pollutants that fall under this category are nutrients and siltation. Historically, in the absence of established numeric nutrient criteria, ADEM and/or EPA would use available data and information coupled with best professional judgment to determine overall use support for a given waterbody. Narrative criteria continue to serve as a basis for determining use attainability and subsequently listing/delisting of waters from Alabama’s §303(d) List. ADEM’s Narrative Criteria are shown in ADEM’s Administrative Code 335-6-10-.06 as follows:

335-6-10-.06 Minimum Conditions Applicable to All State Waters. *The following minimum conditions are applicable to all State waters, at all places and at all times, regardless of their uses:*

(a) State waters shall be free from substances attributable to sewage, industrial wastes or other wastes that will settle to form bottom deposits which are unsightly, putrescent or interfere directly or indirectly with any classified water use.

(b) State waters shall be free from floating debris, oil, scum, and other floating materials attributable to sewage, industrial wastes or other wastes in amounts sufficient to be unsightly or interfere directly or indirectly with any classified water use.

(c) State waters shall be free from substances attributable to sewage, industrial wastes or other wastes in concentrations or combinations, which are toxic or harmful to human, animal or aquatic life to the extent commensurate with the designated usage of such waters.

3.0 Technical Basis for TMDL Development

3.1 Water Quality Target Identification

ADEM continues its efforts to develop comprehensive numeric nutrient criteria for all surface waters throughout Alabama, including rivers/streams, lakes/reservoirs, wetlands, and coastal/estuarine waters. However, until numeric nutrient criteria or some form of quantitative interpretations of ADEM's narrative criteria are developed, the Department will continue to use all available data and information coupled with best professional judgment to make informed decisions regarding overall use support and when establishing targets for TMDLs.

Typically, development of a water quality criterion for a given pollutant involves extensive research using information from many areas of aquatic toxicology. For example, development of numeric criteria for toxic pollutants, such as mercury, involves numerous toxicological studies such as dose/response relationships, bioaccumulation studies, fate and transport studies, and an understanding of both the acute and chronic effects to aquatic life. As part of the toxicological evaluations, EPA performs uncertainty analysis to help guide selection of the recommended water quality criterion for a given pollutant. For toxic pollutants, the more uncertainty revealed during the evaluation, the more conservative (i.e. the lower the value) the recommended criterion becomes.

Nutrients such as phosphorus and nitrogen are essential elements to aquatic life, but can be undesirable when present at sufficient concentrations to stimulate excessive plant growth. Even though these pollutants are generally considered nontoxic (the exception being un-ionized ammonia toxicity to aquatic life), they can impact aquatic life due to their indirect effects on water quality, either when in overabundance or when availability is limited.

ADEM's water quality criteria applying to nutrients are narrative, therefore a numerical translator is needed to define the TMDL target. Based on the historical data collected on Buxahatchee Creek, there is evidence that designated uses are impaired by nutrient over-enrichment. However some uncertainty remains in the exact quantification of the nutrient target due to the complexity of the relationship of cause and effect and the state of the science. This is a very common dilemma in nutrient water quality management, and often warrants an alternate approach. EPA recommends, in the absence of sufficient "effects-based" information, a reference condition approach for determining protective nutrient criteria. With this approach, a numerical value can be empirically developed that can be assumed to inherently protect uses supported in the reference waters. This approach can provide an initial target while continuing studies will allow further evaluation of the cause and effect relationships that might result in refinement of the initial target.

In developing a nutrient target for the Buxahatchee Creek Nutrient TMDL, ADEM has chosen to use a "reference condition" approach for determining the appropriate levels of nutrients necessary to support designated uses. This approach is based on using ambient water quality data from candidate reference streams that are located in characteristically similar regions of Alabama known as ecoregions. An ecoregion is defined as a relatively homogeneous area defined by similar climate, landform, soil, potential natural vegetation, hydrology and other ecologically relevant variables (USEPA, 2000b). "Reference streams" are defined as waterbodies that have been relatively undisturbed or minimally-impacted that can serve as examples of the natural biological integrity of a particular ecoregion. These "reference streams" can be monitored over time to establish a baseline to which other waters can be compared. Reference streams are not necessarily pristine or undisturbed by humans, however they do represent waters within Alabama that are healthy and fully support their designated uses, to include protection of aquatic life. The reference streams selected for a particular analysis depends primarily on the available number of reference streams and associated data within a particular ecoregion. Therefore, the total number of reference sites selected and the aerial scale (i.e. Ecoregion Level III, Level IV) used to represent a reference condition will often vary on a case-by-case basis. ADEM believes that the "reference condition" approach used to determine appropriate nutrient targets for the Buxahatchee Creek TMDL, is reasonable, scientifically defensible, protective of designated uses, and consistent with USEPA guidance.

Normally, ADEM would target only total phosphorus (TP) as the nutrient of concern for a stream that is effluent-dominated such as Buxahatchee Creek. However, since Buxahatchee Creek drains into an embayment of Lay Lake of the Coosa River, which is considered impaired for nutrients, ADEM will also target total nitrogen (TN). ADEM believes an appropriate initial strategy to controlling algal growth in Buxahatchee Creek, is to effectively control phosphorus and nitrogen loadings in the system.

In developing and establishing reference conditions from best available data, frequency distributions are recommended by the *Nutrient Criteria Technical Guidance Manual for Rivers and Streams* (USEPA, 2000b) as the preferred method for setting nutrient criteria. ADEM selected to use the 90^{th} percentile of the data distributions from the selected eco-region reference sites to be used in establishing TP and TN targets. The 90^{th} percentile of the data distribution was considered an appropriate target, since it falls within an acceptable range of "least-impacted" conditions (i.e. upper quartile).

If the TP and TN concentrations of the subject impaired stream are relatively the same or below reference condition levels, then the stream is considered not to be impaired for nutrients. If TP and TN concentrations within the impaired stream are shown to be above reference conditions, then other water quality data and information are used in the evaluation. The additional data and information that can be used includes, but is certainly not limited to, diurnal dissolved oxygen readings, algal biomass measurements (periphyton or suspended algae), habitat assessments, and macroinvertebrate and fish community indices.

The following specific steps were employed to determine the Buxahatchee Creek TP and TN targets:

1. Ecological reference stations located in the same level IV ecoregion as Buxahatchee Creek were identified. The whole watershed includes three different level IV ecoregions, 67(f), 67(g), and 45(a). Ecoregions 67(f) and 67(g) were not employed in the analysis because most of the Buxahatchee Creek watershed is located in 45(a). That being said a review of ecoregions 67(f) and 67(g) show a very similar comparison to 45(a) for TP and TN concentrations. Ecoregion 45(a) represents the Southern Inner Piedmont region.

2. Data from the reference stations in ecoregion 45(a) was then organized into a spreadsheet where the median TP and TN values for each station were determined.

3. The 90^{th} percentiles were then calculated from all the median TP and TN values. These 90^{th} percentiles are used as the target values for TP and TN.

4. Ecoreference station data employed to determine the TP and TN targets can be found in Appendix B.

3.2 Source Assessment

Point Sources in the Buxahatchee Creek Watershed:

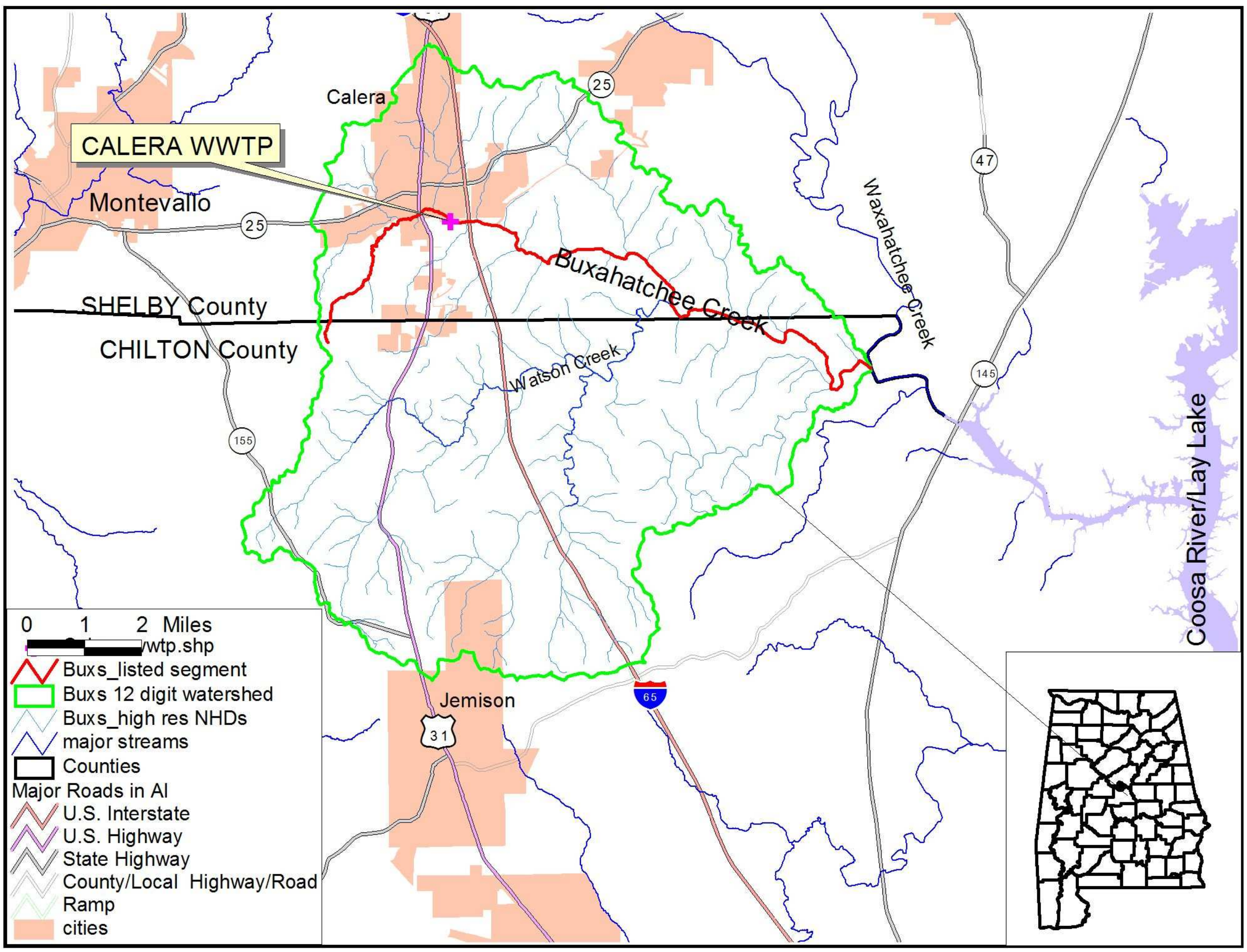
Point source considerations typically represent discharges from wastewater treatment plants, industrial operations, concentrated flows, etc. These operations generally result in some type of loading to the receiving stream. These loadings could be temperature, nutrients, organic matter, etc. There is one point source in the Buxahatchee Creek watershed, the Calera Wastewater Treatment Plant (WWTP). The facility's NPDES permit number is AL0050938 and it is currently permitted for a design flow of 1.5 mgd. Water quality data collected above and below the Calera WWTP discharge location indicates the point source is a significant source of nutrients to Buxahatchee Creek.

The WWTP's current permit includes a total phosphorus limit of 7.1 lb/day based upon a monthly average, which equates to 0.57 mg/l. The facility does not have a current total nitrogen limit.

Buxahatchee Creek is not included in any Municipal Separate Storm Sewer Systems (MS4) area.

Figure 3.2.1 is a point source map of the watershed.

Figure 3.2.1: Point Source in the Buxahatchee Creek Watershed



3.3 Landuse

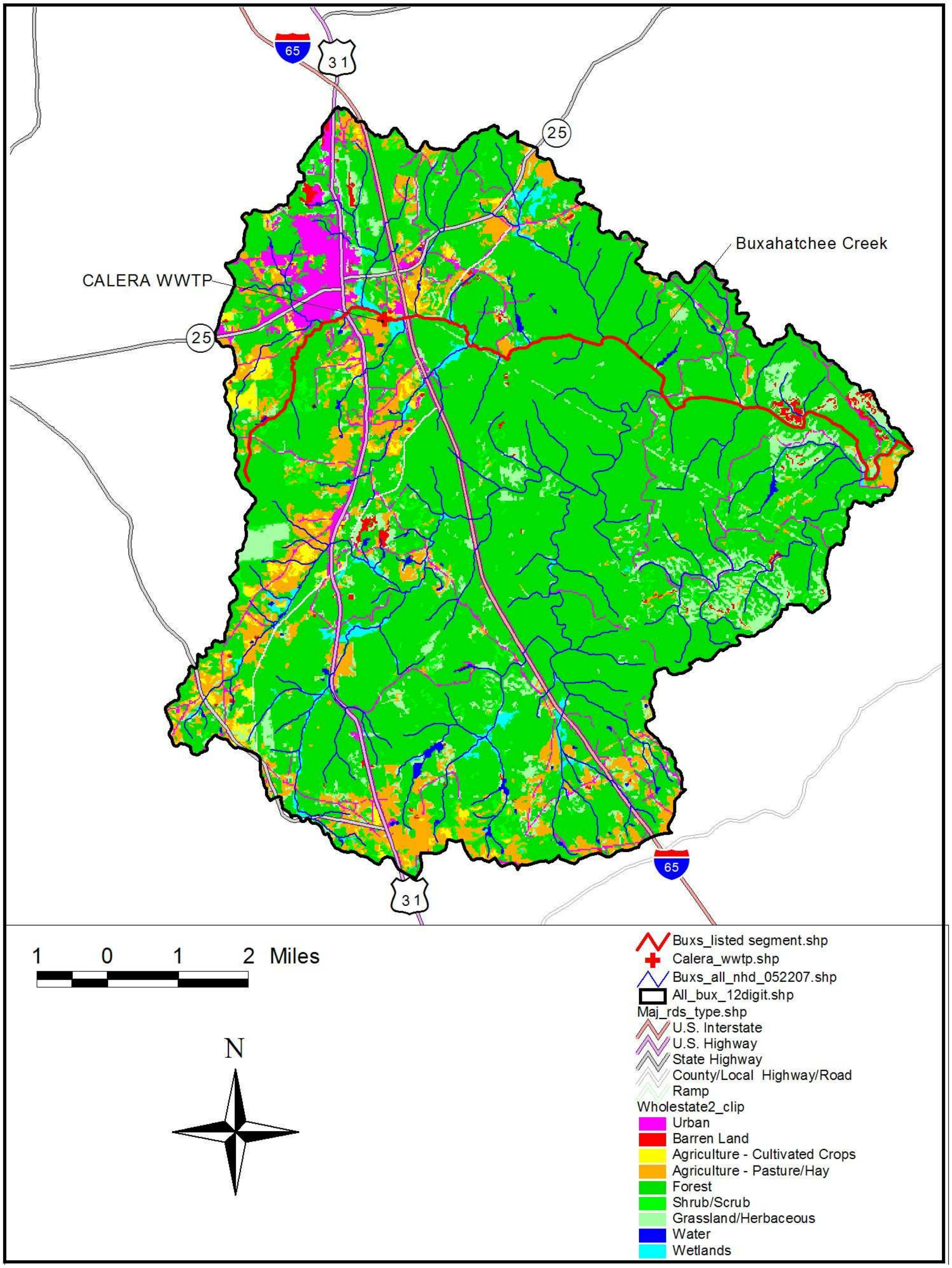
Nonpoint Sources in the Buxahatchee Creek Watershed:
Shown in Table 3.3.1 is a summary of the land usage in the Buxahatchee Creek watershed. The land use map of the watershed is presented in Figure 3.3.1. The predominate land uses within the watershed are agriculture, forest, and developed lands (National Land Cover Dataset (NLCD), 2001).

Each landuse has the potential to contribute to the nutrient loading in the watershed due to nutrients on the land surface that potentially can be washed off into the receiving waters of the watershed. Possible non-point source contributions of impairment could include failing septic systems, agricultural runoff, and runoff from a local golf course in the watershed just east of I-65.

Table 3.3.1: Landuse in the Buxahatchee Creek Watershed

2001 NLCD name	Buxahatchee Creek (sq. miles)	Buxahatchee Creek (%)
Unclassified	0.24	0%
Open Water	0.36	1%
Developed Open Space	3.20	4%
Developed Low Intensity	1.32	2%
Developed Medium Intensity	0.28	0%
Developed High Intensity	0.10	0%
Barren Land (Rock/Sand/Clay)	0.49	1%
Deciduous Forest	26.93	38%
Evergreen Forest	19.91	28%
Mixed Forest	3.21	4%
Shrub/Scrub	1.79	3%
Grassland/Herbaceous	5.13	7%
Pasture/Hay	6.31	9%
Cultivated Crops	1.01	1%
Woody Wetlands	1.19	2%
Emergent Herbaceous Wetlands	0.00	0%
total	71.49	100%
Aggregate Landuse	**(sq. miles)**	**(%)**
all developed	4.90	7%
all agricultural	7.31	10%
all forest	50.05	70%
other	9.22	13%
total	71.49	100%

Figure 3.3.1: 2001 Landuse in the Buxahatchee Creek Watershed



3.4 Data Availability and Analysis

Note: All tables and figures discussed in this section can be found at the end of the section after completion of the narrative.

As stated in the introduction of this report, data from the State's CWS initiatives of 1988 and 1991 suggested impairment of Buxahatchee Creek due to nutrients. Data was also acquired on the creek during the 1996 CWS initiative.

Additionally, there has been a considerable amount of attention devoted to Buxahatchee Creek since 2000, for nutrient impact assessment. The following discussion will be categorized by agency (i.e., agency collecting the data).

ADEM has collected four data sets which are listed below:

The first set, referred to as 303(d) data, was collected by the agency over about a 1-year time interval from April 2000 through April 2001. There were a total of six sampling stations. Data measured included field parameters, lab parameters, and fish, biological and habitat assessments. Field parameters refer to data measured in the field and include such items as flow, DO, temperature, and pH measurements. Lab parameters refer to samples taken in the field, preserved properly, and transported back to an ADEM lab for analysis. Lab parameters include such items as $CBOD_5$, NH_3-N, TP, NO2 + NO3-N, TKN and chlorophyll-a. Fish, macroinvertebrate and habitat assessments were also performed by ADEM's Field Operations personnel. A fish assessment is also referred to as an Index of Biotic Integrity for Fish (or fish IBI). It is an attempt to measure the health and diversity of the fisheries population in the watershed. The goal of a benthic macroinvertebrate assessment is to measure the health and diversity of the ecological communities that reside in the sediments of a stream (such as mayflies, caddisflies, and stoneflies). Relevant data from these stations can be found in Appendix B.

The second set of ADEM data is from two intensive water quality surveys conducted in the summer of 2000. The first survey was conducted from May 22-26; the second, from July 24-27. Data from the first survey consisted of field parameters, time-of-travel data, and diurnal DO data. Data from the second survey was the same as the first plus included lab parameters. The Calera wastewater treatment plant (WWTP) experienced a major upset during the second study. The cause of the upset was used motor oil from a local industrial facility. Station locations were the same as the 303(d) locations plus included three intermediate stations between BXHS-3 and BXHS-4 (identified as BXHS-3A, B and C). Based on field observations during the studies, BXHS-3A was considered to be the most impacted station in the watershed. Noted impacts include visually-observed high densities of periphyton and macrophytes. Relevant data from the two surveys can be found in Appendix B. This includes diurnal DO data at stations BXHS-2, 3, 3A, 4 and WTNS-1. An inspection of these plots reveals diurnal DO swings as large as 8 mg/L. Large DO swings such as this are indicative of photosynthetic/respiration cycles that occur as a result of excessive nutrient loading.

The third set of data collected by ADEM from Buxahatchee Creek was in 2003 as part of a tributary nutrient loading study to the Coosa River. Monthly data was collected from March – October and can be found in the Appendix (included in 303(d) data table).

Table 3.4.1 gives location descriptions for ADEM's 303(d) stations. Figure 3.4.1 is a map of these stations in the watershed.

The most recent ADEM data collection on Buxahatchee Creek occurred in 2005. Data measured included field and lab parameters (monthly March-October) and biological and habitat assessments including macroinvertebrate and periphyton community assessments. The 2005 monthly lab data is being used to determine Non-Point Source (NPS) load reductions and can be found in Appendix B. It should be noted that during this time period the Calera WWTP was in the process of expanding its design flow from 0.75 mgd to 1.5 mgd. During the expansion, process changes occurred which resulted in increased TP and TN loading from the facility from July through the remaining sampling period. This can be clearly seen in the DMR results for the Calera WWTP. A formal report was written up detailing the results of the biological assessments and is included in Appendix C. The conclusion from the report is shown below.

"Macroinvertebrate assessment results indicated the macroinvertebrate communities above and below the Calera WWTP to be in *poor* condition. The poor conditions at BXHS-2 may be at least partly attributed to low flow and the lack of riffle-run habitat. Results of water quality sampling and periphyton bioassessments conducted during 2005 suggest that nutrient enrichment is also affecting the macroinvertebrate communities at BXHS-3a, and, to a lesser extent, BXHS-4. "

The National Council for Air and Stream Improvement (NCASI), a technical organization funded by the pulp and paper industry, has also collected a considerable amount of data in the watershed over the last five years. The purpose of NCASI's involvement was to demonstrate the degree of resources that would normally be required to perform a TMDL of this nature that can be considered technically sound. NCASI performed three intensive water quality surveys during 2001. The first two were performed under dry conditions in July and August of that year. The third study, performed under wet conditions, took place in December. Table 3.4.2 gives location descriptions for the NCASI stations. Figure 3.4.2 is a map of the stations in the watershed. The relevant NCASI data can be found in Appendix B. This includes diurnal DO data.

In addition to the three studies conducted by NCASI, two more studies were conducted by other agencies. The first of these was a sediment oxygen demand (SOD) study performed by EPA Region 4. The study was conducted the week of September 24, 2001. Table 3.4.3 lists location descriptions for the SOD study while Figure 3.4.3 is a map of the stations. Data from the SOD study can be found in Appendix B.

The second study was performed under contract to NCASI and was conducted by Limno-Tech of Ann Arbor, Michigan. It was a reaeration study done from September 11-13, 2002. Table 3.4.4 lists location descriptions for the reaeration study while Figure 3.4.4 is a map of the stations. Data from the reaeration study can be found in Appendix B.

Any data for Buxahatchee Creek not listed in Appendix B is available upon request.

Table 3.4.1: ADEM Sampling Station Location Descriptions

Station Number	Waterbody Name	County	Location Description	Latitude	Longitude
BXHS-1	Buxahatchee Creek	Shelby	Buxahatchee Creek @ US Hwy 31 in Calera.	33.0958	-86.7527
BXHS-2	Buxahatchee Creek	Shelby	Buxahatchee Creek upstream of the Calera WWTP outfall.	33.0943	-86.7439
BXHS-3	Buxahatchee Creek	Shelby	Buxahatchee Creek 100 feet upstream of the southbound lane of I-65.	33.0937	-86.7384
BXHS-3A	Buxahatchee Creek	Shelby	Buxahatchee Creek at power line crossing approx 0.2 mi downstream of unnamed tributary	33.08583	-86.72083
BXHS-4	Buxahatchee Creek	Shelby	Buxahatchee Creek upstream of Hiawatha Road (Shelby Co. Rd. 161) and Watson Branch.	33.0735	-86.6775
BXHS-5	Buxahatchee Creek	Shelby	Buxahatchee Creek downstream of Hiawatha Road (Shelby Co. Rd. 161) and Watson Branch.	33.07142	-86.67649
WTNS-1	Watson Creek	Shelby	Watson Creek upstream of Hiawatha Rd. (Shelby Co. Rd. 161) and Buxahatchee Creek.	33.0734	-86.6783
CAWW-1	Calera WWTP Outfall	Shelby	Calera WWTP outfall @ Buxahatchee Creek.	33.0941	-86.7444

Table 3.4.2: NCASI Sampling Station Location Descriptions

Station ID	Location Description	Longitude (dec. deg.)	Latitude (dec. deg.)
0B	Buxahatchee Creek at U.S. HWY 31. Same as ADEM station BXHS-1.	-86.75278	33.09553
2T	Mouth of unnamed tributary (UT) to Buxahatchee Creek just east of U.S. Hwy 31.	-86.74859	33.09683
1B	Buxahatchee Creek just upstream of 2T at 9th Street.	-86.74903	33.09641
12E	Calera WWTP effluent. Same as ADEM station CAWW-1.	-86.74538	33.09445
P1	Buxahatchee Creek just upstream of Calera WWTP. Same as ADEM station BXHS-2.	-86.74487	33.09501
P2	Buxahatchee Creek just west of Interstate 65. Same as ADEM station BXHS-3.	-86.73836	33.09364
3T	Mouth of UT draining through the golf course area.	-86.73553	33.09397
4B	Buxahatchee Creek near 3T.	-86.73507	33.0936
5T	Mouth of UT draining from South Calera area.	-86.72396	33.0866
P4	Buxahatchee Creek near 5T.	-86.72352	33.08669
6B	Buxahatchee Creek approximately 1 mile downstream of P4.	-86.71525	33.08359
P5	Buxahatchee Creek approximately 1 mile downstream of 6B.	-86.70799	33.08592
8T	Mouth of UT draining from the Ozan area.	-86.69079	33.08597
7B	Buxahatchee Creek approximately 1/3 mile downstream of 8T.	-86.68682	33.08489
10T	Watson Creek near its mouth. Same as ADEM station WTNS-1.	-86.67804	33.07308
9B	Buxahatchee Creek just upstream of the mouth of Watson Creek. Same as ADEM station BXHS-4.	-86.67765	33.07403
11B	Buxahatchee Creek aproximately two miles upstream of its mouth and not far upstream of Sawyer Cove.	-86.63386	33.06219

Table 3.4.3: EPA SOD Sampling Station Location Descriptions

Station I.D.	Location	GPS Coordinates
9B	Hiawatha Road below confluence of Buxahatchee Creek and Watson Creek	N 33° 04' 22.08" W 086° 40' 38.65"
4B	Timberline Golf Course downstream of golf course pond discharge to Buxahatchee Creek	N 33° 05' 38.20" W 086° 44' 08.52"
2B	Calera Wastewater Treatment Plant downstream of discharge	N 33°05" 37.85" W 086° 44' 37.88"
P1	Calera Wastewater Treatment Plant upstream of discharge	N 33°05'40.55" W 086°44'38.39"

Table 3.4.4: Limno-Tech Reaeration Sampling Station Location Descriptions

Station ID	Location Description	Longitude (dec. deg.)	Latitude (dec. deg.)
INJT1	Injection point of downstream reach	-86.73557	33.09382
SAMP1A	1st sampling point of downstream reach	-86.73478	33.09365
SAMP1B	2nd sampling point of downstream reach	-86.73340	33.09293
INJT2	Injection point of upstream reach	-86.74392	33.09403
SAMP2A	1st sampling point of upstream reach	-86.74352	33.09330
SAMP2B	2nd sampling point of upstream reach	-86.74023	33.09365

Figure 3.4.1: Map of ADEM Sampling Stations

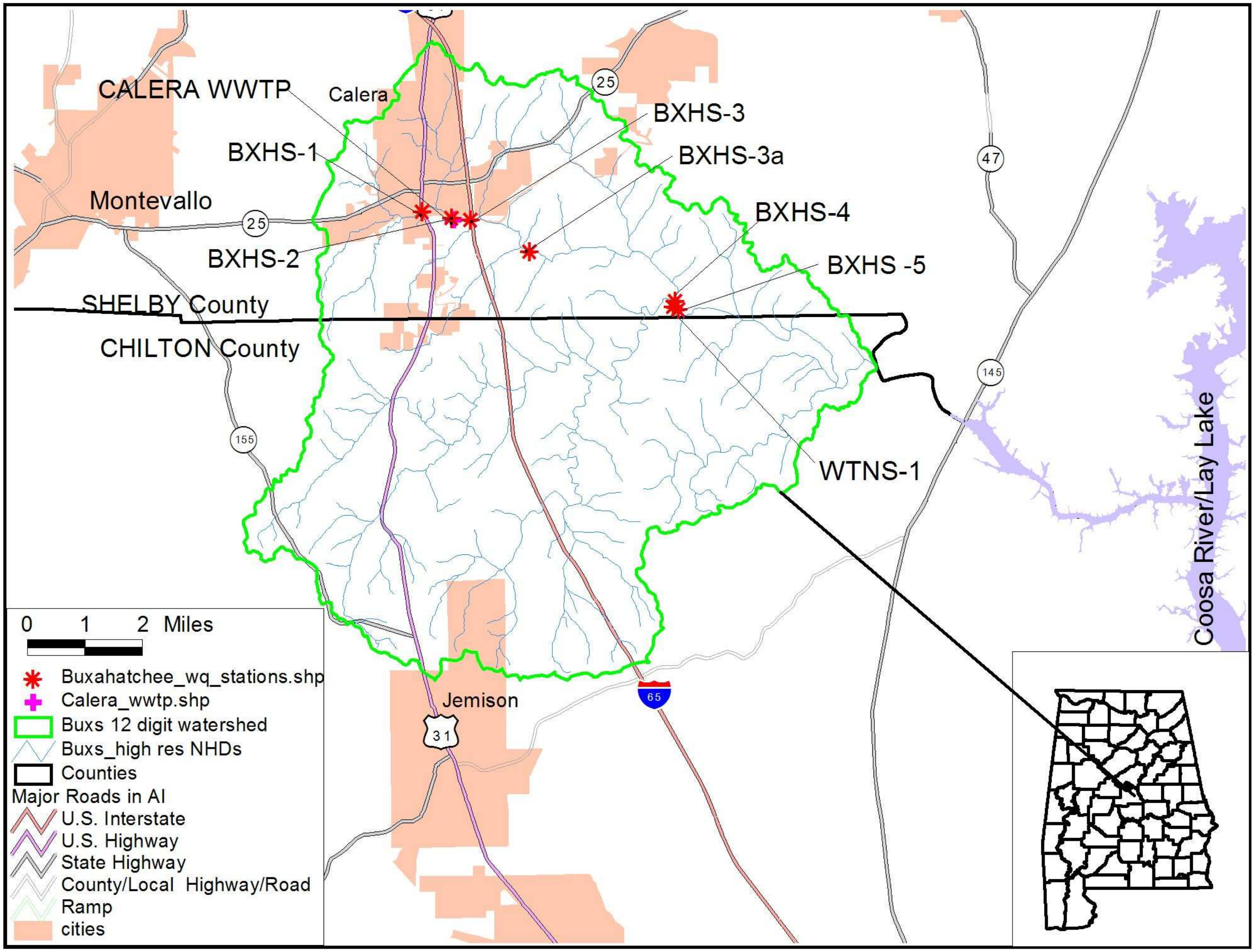


Figure 3.5.2: Map of NCASI Sampling Stations

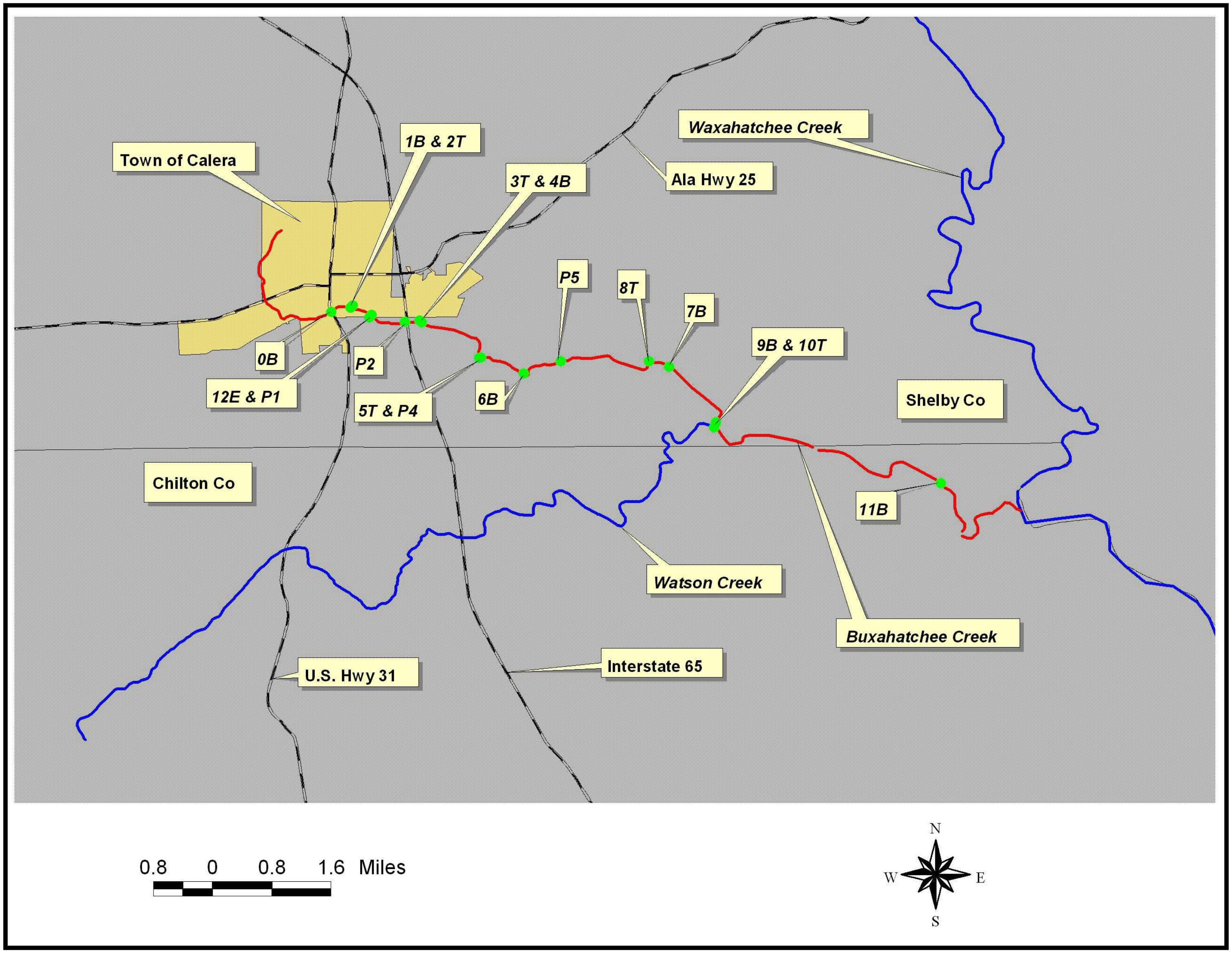


Figure 3.5.3: Map of EPA SOD Sampling Stations

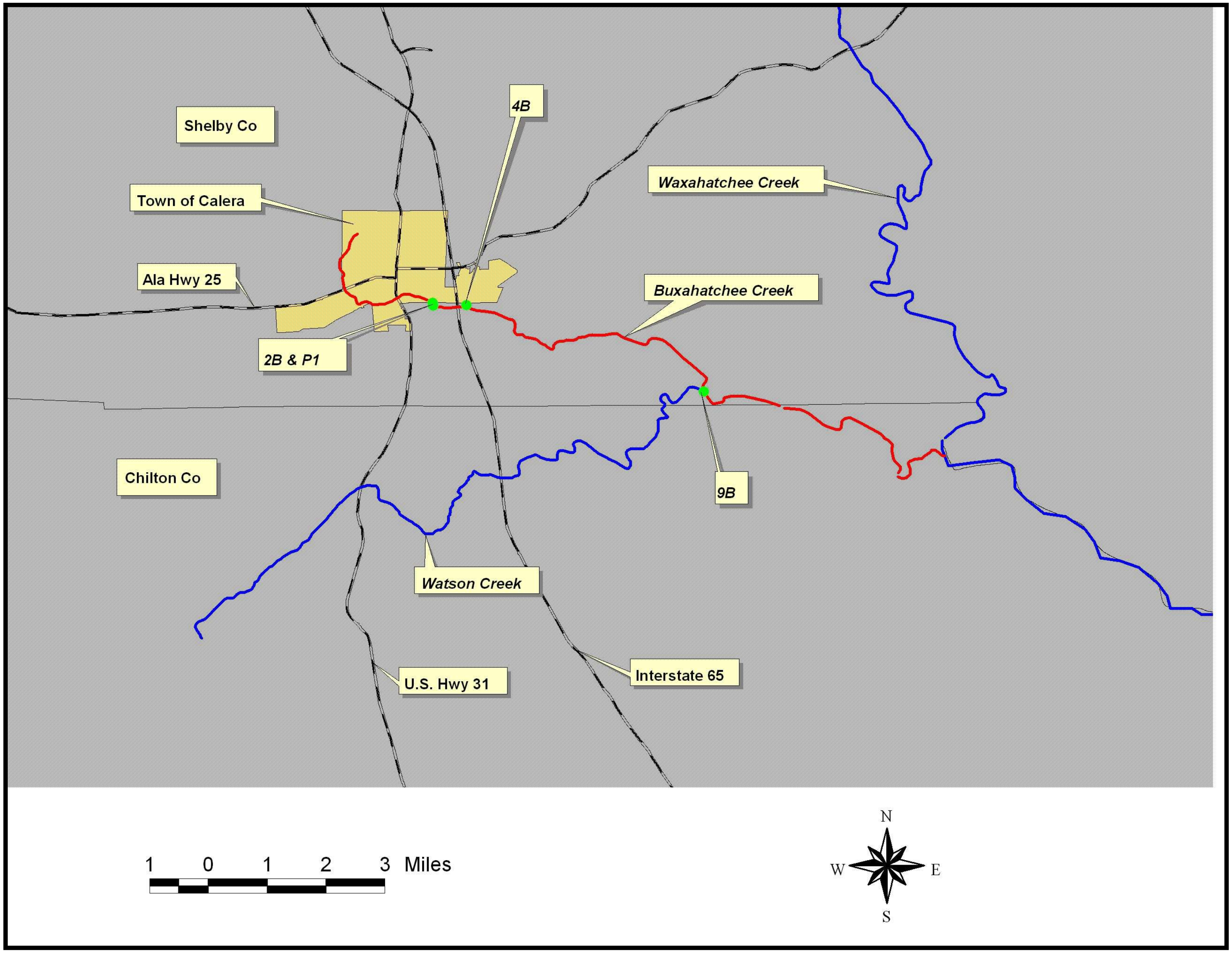
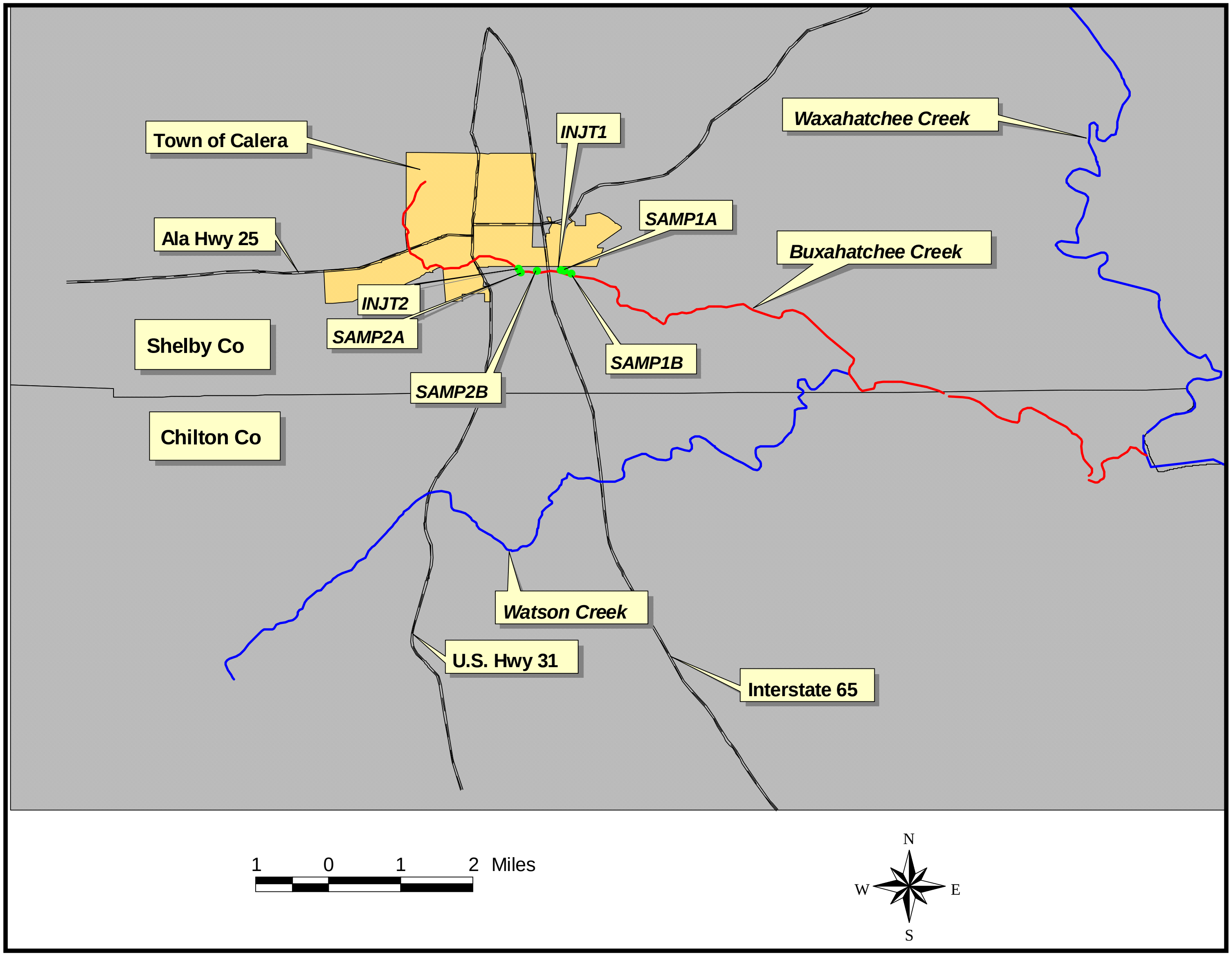


Figure 3.5.4: Map of Limno-Tech Reaeration Sampling Stations



4.0 Total Maximum Daily Load Development for Buxahatchee Creek

This section presents the TMDL developed to address nutrients for Buxahatchee Creek. A TMDL is the total amount of a pollution load that can be assimilated by the receiving water while still achieving water quality standards. TMDLs can be expressed in terms of mass per time or by other appropriate measures. TMDLs are comprised of the sum of individual waste load allocations (WLAs) for point sources, load allocations (LAs) for non-point sources, and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the following equation:

$$\text{TMDL} = \Sigma\text{WLAs} + \Sigma\text{LAs} + \text{MOS}$$

In order to develop the TMDL, the following steps will be defined:

1. Numeric Target for TMDL
2. Existing/Baseline Conditions
3. Critical Conditions
4. Margin of Safety
5. Seasonal Variation
6. TMDL Calculation Method and Results

4.1 TMDL Numeric Targets

The TMDL endpoints represent the in-stream water quality target used in quantifying the load reduction that maintains water quality standards. The TMDL endpoints can be a combination of water quality standards, both numeric and narrative, and surrogate parameters that would ensure the standards are being met.

Normally, ADEM would target only total phosphorus (TP) as the nutrient of concern for a stream that is effluent-dominated such as Buxahatchee Creek. However, since Buxahatchee Creek drains into an embayment of Lay Lake of the Coosa River, which is considered impaired for nutrients, ADEM will also target total nitrogen (TN).

Establishing TP and TN targets that fully support the designated uses of Buxahatchee Creek is part of the lengthy and complex process of TMDL development. The nutrient targets were developed using a “reference condition” approach using data from eco-region 45(a), and taking the 90^{th} percentile of this data to calculate the target concentrations. The TP and TN target concentrations for Buxahatchee Creek are 0.048 mg/L and 0.298 mg/L, respectively.

4.2 Existing/Baseline Conditions

The results of using in-stream data and discharge monitoring report (DMR) data provide the existing condition for Buxahatchee Creek. Since target values are based on growing season median values it was determined that existing conditions should also be based on growing season medians.

Existing conditions for non-point source loading for Buxahatchee Creek will be based on the most recent data collected, which is from 2005. Station BXHS-2 was selected as the most appropriate location for non-point source (NPS) load calculations because it is upstream of any point source discharge; therefore, it has no influence from point sources. Data and calculations for NPS loads can be seen in Section 4.6.

Existing conditions for point source loading to Buxahatchee Creek will be based on DMR data reported to ADEM for the 2006 growing season. The reason for using 2006 is further described in Section 4.6.1

4.3 Critical Conditions

It is important when developing a TMDL that it is protective of water quality over a range of possible conditions that might occur within the listed segment. In EPA's Nutrient Criteria Technical Guidance Manual: Rivers and Streams, it states that 'Nutrient and algal problems are frequently seasonal in streams and rivers, so sampling periods can be targeted to the seasonal periods associated with nuisance problems.' ADEM has determined that the seasonal period associated with nutrient enrichment that results in nuisance algal problems for Buxahatchee Creek is the growing season of April through October. Typically, critical conditions specify a flow that will represent an extreme low flow regime or a loading that represents a high possible value. If the growing season median concentration is less than the target concentration, then the loading to the system is said to be protective of water quality. However, if the growing season median concentration is greater than the target, then the loading may not be protective of water quality. This loading, therefore, needs to be reduced until the target concentrations are met. The loading that is referred to in this system is total phosphorus and total nutrients.

Two critical conditions were employed for this TMDL. The first is the growing season months (April-October) for algal populations. The second is the permit, or design wastewater flows, for the Calera WWTP. The Calera WWTP is currently permitted for a 1.5 mgd design wasteflow.

4.4 Margin of Safety

There are two methods for incorporating a MOS in the analysis: a) by implicitly incorporating the MOS using conservative model assumptions to develop allocations; b) by explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations.

The MOS in this TMDL is implicit since the total phosphorus target and the total nitrogen target were derived using ecological reference streams, which are considered to represent least impacted conditions. Also, a mass balance procedure was employed to estimate allowable TP and TN loads to Buxahatchee. Since no algal uptake is considered in this approach, the allowable TP and TN loads will be conservative.

4.5 Seasonal Variation

The TP and TN numeric targets are single values which represent the range of values measured over multiple-year growing seasons at the designated reference sites. Therefore, application and interpretation of the nutrient targets for Buxahatchee Creek should consider that ambient TP and TN concentrations may exceed the target at times while still maintaining conditions similar to those in streams that fully support the designated use of aquatic life, as long as the growing season median concentrations are maintained. Application of the proposed nutrient targets of 0.048 mg/l for TP and 0.298 mg/l for TN must consider the methodology of the ecoregion reference stream approach that was used to develop the targets. Ecoregion reference stream site data were assessed on a growing-season basis that accounts for natural variability. Therefore, it would be inappropriate to expect Buxahatchee Creek not to exhibit natural variability during the growing season including higher, as well as lower, levels of phosphorus and nitrogen while attaining the growing season median target values. The April-October growing season was determined to be the appropriate time frame for managing TP and TN to control periphyton in Buxahatchee Creek. It was determined that winter reductions (i.e., non-growing season) would not be necessary since high flows, cool temperatures, and low availability of substrate and light, limit algal production. Application of the TP and TN targets may be reviewed based on future research as effects-based links become more tangible. It is a valid observation that certain streamflow and wastewater discharge conditions will combine to result in TP and TN levels higher and lower than the target. From a permitting standpoint, WWTPs are required to meet nutrient discharge levels on a monthly average basis during the growing season.

4.6 TMDL Calculation Method and Results

4.6.1 Waste Load Allocation (WLA)

There is only one point source in the Buxahatchee Creek watershed – the Calera Wastewater Treatment Plant (WWTP). Therefore, the total existing WLA was calculated from this facility. Due to the nutrient targets being derived from growing season medians, the decision was made to calculate the existing WLA based on the growing season median loads using monthly DMR data. DMR data from 2006 was chosen to calculate the growing season median load. 2005 DMR data was not used since the WWTP expanded its design flow from 0.75 mgd to 1.5 mgd approximately mid-year. During this expansion several process changes occurred that resulted in non-typical nutrient loads to be discharged from the WWTP. DMR data from 2007 cannot be used since a complete growing season data set is not available. Therefore, the median monthly average TP and TN loads for the 2006 growing season would be the most represented values to use for existing WLA loads.

The allowable WLA was calculated using the WWTP permitted design flow (1.5 mgd) and the instream target values described in Section 4.1.1. The monthly and median WLA existing loads, WLA allowable loads, and the percent reduction needed to meet the allowable load are shown below:

Year 2006	Monthly AVG TP (lbs/day)	Monthly Ave TN (lbs/day)
January	137.94	52.27
February	114.56	38.33
March	64.4	36.41
April	82.45	28.6
May	47.89	39.56
June	32.85	13.83
July	17.36	13.46
August	10.62	6.13
September	6.11	19.25
October	3.48	27
November	0.085	95.5
December	0.18	49.86
2006 Growing Season Median	17.36	19.25
Permit limit	7.1	N/A
Allowable load	0.60	3.73
Percent reduction based on 2006 DMR data	97%	81%
Percent reduction based on Permit limit	92%	N/A

4.6.2 Load Allocation (LA)

The LA for the Buxahatchee Creek watershed was calculated based upon water quality data collected at station BXHS-2 located just upstream of the Calera WWTP discharge. Station BXHS-2 was determined to be the most representative of non-point source (NPS) pollution to Buxahatchee Creek since it is not influenced from the WWTP discharge. It was determined that the ADEM 303(d) 2005 data set for BXHS-2 would be most representative of current NPS loadings to Buxahatchee Creek. The 2005 data set is the most current data collected on Buxahatchee Creek and monthly samples were collected through the growing season with the exception of September.

After the data set was chosen, TP and TN loads were calculated for each sampling event. The median load value was then calculated from the growing season months (April – October). The median TP and TN load values are considered to be the existing TP and TN load allocations (LA) for Buxahatchee Creek. The allowable LA was calculated using the same hydraulic conditions as used to compute the existing LA and the in-stream target values described in Section 4.1.1. Then the percent reductions were calculated from the existing load to the allowable load. It should be noted that no reduction will be required for TP in the LA. Only a TN reduction will be required for the LA. The monthly and median LA existing loads, LA allowable loads, and the percent reduction needed to meet the allowable load are shown below:

Station_ID	Date	Stream Flow (cfs)	Total-P (mg/l)	Total-P (lbs/day)	TN (mg/l)	TN (lbs/day)
BXHS-2	3/23/2005 *	28.6	0.061	9.40	0.533	82.15
BXHS-2	4/12/2005	21.5	0.082	9.50	0.776	89.98
BXHS-2	5/10/2005	1.1	0.038	0.23	0.347	2.05
BXHS-2	5/31/2005	4.4	0.042	1.00	0.540	12.81
BXHS-2	7/5/2005	0.7	0.038	0.14	0.667	2.52
BXHS-2	8/9/2005	1.4	0.034	0.26	0.230	1.74
BXHS-2	10/20/2005	0.4	0.005	0.01	0.624	1.34
Growing Season median loads				0.24		2.29
* this sample included for info but was not used in calculations						
		Allowable load		0.32		1.45
		Percent Reduction		N/A		37%

A summary table depicting values described above is shown below.

Polluant	Existing loads WLA	Existing loads LA	Allowable loads WLA	Allowable loads LA	Reductions WLA*	Reductions LA
TP (lbs/day)	17.36	0.24	0.60	0.32	97%	N/A
TN (lbs/day)	19.25	2.29	3.73	1.45	81%	37%

*The Percent Reduction based on current permit limits for TP would equate to 92 %

4.6.3 TMDL

The WLA and the LA components of the TMDL employ the same hydraulic conditions as used to calculate the allowable loads discussed above. The TMDL values are shown below.

TMDL = WLA + LA + MOS*			
Polluant	**TMDL**	**WLA**	**LA**
TP (lbs/day)	0.92	0.60	0.32
TN (lbs/day)	5.17	3.73	1.45

*** implicit MOS**

5.0 Follow Up Monitoring

ADEM has adopted a basin approach to water quality management; an approach that divides Alabama's fourteen major river basins into five groups. Each year, the ADEM water quality resources are concentrated in one of the basin groups. The goal is to continue to monitor §303(d) listed waters. This monitoring will occur in each basin according to the schedule below:

Monitoring Schedule for Alabama's Major River Basins

River Basin Group	Schedule
Cahaba/Black Warrior	2007
Tennessee	2008
Choctawhatchee/Chipola / Perdido-Escambia/Chattahoochee	2009
Tallapoosa/Alabama/ Coosa	2010
Escatawpa/Upper Tombigbee/Lower Tombigbee/Mobile	2011

Monitoring will help further characterize water quality conditions resulting from the implementation of WLA reductions and best management practices in the watershed.

6.0 Public Participation

As part of the public participation process, this TMDL will be placed on public notice and made available for review and comment. A public notice will be prepared and published in the four major daily newspapers in Montgomery, Huntsville, Birmingham, and Mobile, as well as submitted to persons who have requested to be on ADEM's postal and electronic mailing distributions. In addition, the public notice and subject TMDL will be made available on ADEM's Website: www.adem.state.al.us. The public can also request hard or electronic copies of the TMDL by contacting Ms. Daphne Smart at 334-

271-7827 or dsmart@adem.state.al.us. The public will be given an opportunity to review the TMDL and submit comments to the Department in writing. At the end of the comment period, all written comments received during the public notice period will become part of the administrative record. ADEM will consider all comments received during the comment period by the public prior to final completion of this TMDL and subsequent submission to EPA Region 4 for final approval.

Appendix A

References

United States Environmental Protection Agency. 1991. Guidance for Water Quality-Based Decisions: The TMDL Process, Office of Water, EPA 440/4-91-001.

Alabama Clean Water Strategy Water Quality Assessment Report, May 1989.

Alabama Clean Water Strategy Water Quality Assessment Report, December 1992.

Alabama Clean Water Strategy Water Quality Assessment Report, 1996.

United States Environmental Protection Agency. 1999. Protocol for Developing Nutrient TMDLs, Office of Water, EPA 841-B-99-007.

USEPA 2000a. Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria. Rivers and Streams in Ecoregion XI. United States Environmental Protection Agency, Office of Water. EPA 822-B-00-020.

USEPA 2000b. Nutrient Criteria Technical Guidance Manual: River and Streams. United States Environmental Protection Agency, Office of Water. EPA 822-B-00-002.

Appendix B
Water Quality Data

Total Phosphorus for Ecoregion Reference Stations in Ecoregion 45 (a)

CHNE-18--45(a)	
9/19/2000	0.08
4/8/2004	0.044
5/4/2004	0.057
6/10/2004	0.042
7/1/2004	0.055
8/5/2004	0.039
8/5/2004	0.059
9/9/2004	0.047
10/26/2004	0.059
4/7/2005	0.079
5/5/2005	0.061
6/8/2005	0.042
7/14/2005	0.055
8/4/2005	0.032
10/20/2005	0.013
median	0.055

EMKT-14--45(a)	
9/14/2000	0.01
4/7/2004	0.022
5/6/2004	0.031
6/3/2004	0.016
7/15/2004	0.019
8/18/2004	0.022
8/18/2004	0.029
9/2/2004	0.044
10/14/2004	0.004
4/27/2005	0.047
5/17/2005	0.033
6/22/2005	0.038
7/25/2005	0.011
8/16/2005	0.056
10/4/2005	0.035
10/4/2005	0.04
median	0.030

PNTC-11--45(a)	
9/14/2000	0.02
4/10/2003	0.019
5/8/2003	0.083
6/9/2003	0.034
7/10/2003	0.026
8/4/2003	0.039
9/4/2003	0.029
10/16/2003	0.042
4/7/2005	0.053
5/4/2005	0.065
6/7/2005	0.042
7/13/2005	0.043
8/3/2005	0.042
10/18/2005	0.011
median	0.041

HCR-1--45(a)	
7/9/1992	0.009
6/15/1993	0.01
6/14/1994	0.004
5/18/1995	0.04
10/17/1997	0.05
5/12/1998	0.004
6/29/1998	0.004
9/1/1998	0.05
5/20/1999	0.004
6/22/1999	0.004
7/20/1999	0.004
8/19/1999	0.061
9/16/1999	0.004
9/13/2000	0.02
4/7/2004	0.02
5/6/2004	0.031
6/3/2004	0.015
6/3/2004	0.01
7/15/2004	0.049
8/18/2004	0.019
9/2/2004	0.045
10/14/2004	0.021
4/27/2005	0.031
5/17/2005	0.03
6/22/2005	0.009
7/25/2005	0.012
8/16/2005	0.055
10/4/2005	0.046
median	0.020

CRHR-9--45(a)	
9/13/2000	0.02
4/7/2004	0.021
5/6/2004	0.03
6/3/2004	0.012
7/15/2004	0.021
8/18/2004	0.026
9/2/2004	0.077
10/14/2004	0.023
4/28/2005	0.067
median	0.023

JNSC-16--45(a)	
9/14/2000	0.03
4/29/2004	0.057
5/25/2004	0.066
7/1/2004	0.036
7/12/2004	0.031
8/24/2004	0.03
9/23/2004	0.044
10/28/2004	0.029
10/31/2005	0.004
median	0.031

90th percentile of all medians = 0.048 mg/l

Total Nitrogen for Ecoregion Reference Stations in Ecoregion 45 (a)

CHNE-18--45(a)	
9/19/2000	0.154
4/8/2004	1.002
5/4/2004	0.457
6/10/2004	0.626
7/1/2004	0.687
8/5/2004	0.206
8/5/2004	0.205
9/9/2004	0.463
10/26/2004	0.237
4/7/2005	0.2947
5/5/2005	0.4213
6/8/2005	0.3433
7/14/2005	0.4677
8/4/2005	0.233
10/20/2005	0.221
median	0.343

EMKT-14--45(a)	
9/14/2000	0.213
4/7/2004	0.196
5/6/2004	0.242
6/3/2004	0.3
7/15/2004	0.222
8/18/2004	0.187
8/18/2004	0.187
9/2/2004	0.177
10/14/2004	0.153
4/27/2005	0.2153
5/17/2005	0.19
6/22/2005	0.5673
7/25/2005	0.0837
8/16/2005	0.277
10/4/2005	0.3477
10/4/2005	0.202
median	0.208

PNTC-11--45(a)	
9/14/2000	0.292
4/10/2003	0.153
5/8/2003	0.163
6/9/2003	0.162
7/10/2003	0.153
8/4/2003	1.551
9/4/2003	0.19
10/16/2003	0.165
4/7/2005	0.157
5/4/2005	0.185
6/7/2005	0.1685
7/13/2005	0.2956
8/3/2005	0.153
10/18/2005	0.64
median	0.167

HCR-1--45(a)	
7/9/1992	0.31
6/15/1993	0.176
6/14/1994	0.042
5/18/1995	0.19
10/17/1997	0.16
5/12/1998	0.2
6/29/1998	0.22
9/1/1998	0.38
5/20/1999	0.269
6/22/1999	0.228
7/20/1999	0.641
8/19/1999	0.735
9/16/1999	0.162
9/13/2000	0.204
4/7/2004	0.296
5/6/2004	0.223
6/3/2004	0.626
6/3/2004	0.302
7/15/2004	0.228
8/18/2004	0.2
9/2/2004	0.177
10/14/2004	0.153
4/27/2005	0.2
5/17/2005	0.173
6/22/2005	0.4772
7/25/2005	0.201
8/16/2005	0.199
10/4/2005	0.192
median	0.203

CRHR-9--45(a)	
9/13/2000	0.259
4/7/2004	0.218
5/6/2004	0.268
6/3/2004	0.326
7/15/2004	0.246
8/18/2004	0.184
9/2/2004	0.946
10/14/2004	0.153
4/28/2005	0.253
median	0.253

JNSC-16--45(a)	
9/14/2000	0.495
4/29/2004	0.228
5/25/2004	0.221
7/1/2004	0.228
7/12/2004	0.341
8/24/2004	0.195
9/23/2004	0.198
10/28/2004	0.153
10/31/2005	0.153
median	0.221

90th percentile of all medians = 0.298 mg/l

ADEM 2000-2001 303(d) data									
Station Number	Date	Flow (cfs)	Total P (mg/l)	Total N (mg/l)	Station Number	Date	Flow (cfs)	Total P (mg/l)	Total N (mg/l)
BXHS-001	4/13/2000	***	0.03	0.561	BXHS-004	4/13/2000	14.5	0.035	0.624
BXHS-001	5/2/2000	***	0.007	1.075	BXHS-004	5/2/2000	2.6	0.049	0.976
BXHS-001	1/18/2001	***	0.004	0.79	BXHS-004	7/26/2000	***	0.062	0.305
BXHS-001	2/21/2001	***	0.004	0.646	BXHS-004	7/26/2000	***	0.098	0.511
BXHS-001	3/8/2001	***	0.004	0.359	BXHS-004	7/27/2000	***	0.809	0.977
BXHS-001	4/19/2001	***	0.08	0.353	BXHS-004	9/5/2000	1.8	0.085	0.348
BXHS-002	4/13/2000	3.8	0.008	0.409	BXHS-004	10/4/2000	0.1	0.192	1.188
BXHS-002	5/2/2000	0.6	0.027	0.785	BXHS-004	1/18/2001	48.8	0.091	0.732
BXHS-002	7/26/2000	***	0.328	1.625	BXHS-004	2/21/2001	18.5	0.004	0.812
BXHS-002	7/26/2000	***	0.085	0.808	BXHS-004	3/8/2001	28.0	0.019	0.82
BXHS-002	7/27/2000	***	0.292	1.706	BXHS-004	4/19/2001	6.8	0.07	0.332
BXHS-002	9/5/2000	***	0.085	0.924	CAWW-001	4/13/2000	.68	0.782	6.436
BXHS-002	10/4/2000	.009	0.032	0.764	CAWW-001	5/2/2000	.59	0.004	0.441
BXHS-002	1/18/2001	12.7	0.094	1.057	CAWW-001	7/27/2000	***	5.273	20.054
BXHS-002	2/21/2001	5.7	0.004	0.673	CAWW-001	9/5/2000	.834	0.421	24.302
BXHS-002	3/8/2001	8.0	0.054	1.355	CAWW-001	10/4/2000	.52	3.802	27.303
BXHS-002	4/19/2001	2.4	0.06	0.329	CAWW-001	1/18/2001	1.2376	0.929	5.457
BXHS-003	4/13/2000	3.8	0.158	1.547	CAWW-001	2/21/2001	1.238	0.974	4.688
BXHS-003	5/2/2000	***	0.561	3.748	CAWW-001	3/8/2001	.99	0.855	5.82
BXHS-003	7/26/2000	***	0.085	0.808	CAWW-001	4/19/2001	1.22	0.94	1.778
BXHS-003	7/26/2000	***	6.199	21.066	WTNS-001	4/13/2000	25.2	0.004	0.446
BXHS-003	7/26/2000	***	3.654	5.638	WTNS-001	5/2/2000	3.9	0.936	4.037
BXHS-003	7/26/2000	***	2.609	4.545	WTNS-001	7/26/2000	***	0.044	0.363
BXHS-003	7/27/2000	***	1.017	4.308	WTNS-001	7/26/2000	***	0.065	0.576
BXHS-003	9/5/2000	***	4.24	22.215	WTNS-001	7/27/2000	***	0.218	0.696
BXHS-003	10/4/2000	***	4.869	33.601	WTNS-001	9/5/2000	***	0.01	0.572
BXHS-003	1/18/2001	***	0.374	1.733	WTNS-001	10/4/2000	***	0.285	1.62
BXHS-003	2/21/2001	***	0.004	1.214	WTNS-001	1/18/2001	66.1	0.004	0.15
BXHS-003	3/8/2001	***	0.175	1.84	WTNS-001	2/21/2001	51.7	0.004	0.334
BXHS-003	4/19/2001	***	0.33	3.118	WTNS-001	3/8/2001	52.6	0.004	0.591
*** no flow taken					WTNS-001	4/19/2001	17.3	0.06	0.174

ADEM -2003- 303(d) DATA

Station_ID	Date	Total-P (mg/l)	Total-N (mg/l)	Stream Flow (cfs)	Reason No Flow
BXHS -5	3/20/03	0.039	1.262	162.5	
BXHS -5	4/3/03	0.068	0.238	22.4	
BXHS -5	5/8/03	0.101	0.278		not wadeable (too deep)
BXHS -5	6/5/03	0.034	0.813		not wadeable (too deep)
BXHS -5	7/17/03	0.203	0.382		flow conditions dangerous
BXHS -5	7/17/03	0.203	0.399		flow conditions dangerous
BXHS -5	8/7/03	0.094	0.517	62.5	
BXHS -5	9/11/03	0.106	0.667	16.7	
BXHS -5	10/9/03	0.334	3.35	6	
Growing Season Median		0.1035	0.458		

ADEM 2005 Lab Data & Calera WWTP DMR Data

Station_ID	Date	Measured Stream Flow (cfs)	* Ratioed Stream Flows based off BXHS-4	Total-P (mg/l)	** Total-P (lbs/day)	TN (mg/l)	** TN (lbs/day)
BXHS-2	3/23/2005	28.6	29.98	0.061	9.40	0.533	82.15
BXHS-2	4/12/2005	21.5	19.87	0.082	9.50	0.776	89.98
BXHS-2	5/10/2005	1.1	2.12	0.038	0.23	0.347	2.05
BXHS-2	5/31/2005	4.4	6.19	0.042	1.00	0.540	12.81
BXHS-2	7/5/2005	0.7	1.48	0.038	0.14	0.667	2.52
BXHS-2	8/9/2005	1.4	2.23	0.034	0.26	0.230	1.74
BXHS-2	10/20/2005	visible but not detectable	0.40	0.005	0.01	0.624	1.33
Growing Season median flow-concentration-loads			**2.178**	**0.038**	**0.24**	**0.582**	**2.29**
BXHS-3	3/23/2005	29.9	37.07	0.118	19.02	0.845	136.22
BXHS-3	4/12/2005	not measured	24.58	0.101	13.38	0.927	122.82
BXHS-3	5/10/2005	not measured	2.63	0.752	10.65	1.206	17.08
BXHS-3	5/31/2005	not measured	7.66	0.103	4.25	0.926	38.24
BXHS-3	7/5/2005	2.8	1.83	1.736	26.20	4.825	72.82
BXHS-3	8/9/2005	not measured	2.76	5.766	85.81	2.284	33.99
BXHS-3	10/20/2005	not measured	0.49	2.275	6.01	2.235	5.90
Growing Season median flow-concentration-loads			**2.694**	**1.244**	**12.02**	**1.720**	**36.12**
BXHS-3A	3/23/2005	56	56.00	0.09	27.17	0.639	192.80
BXHS-3A	4/12/2005	not measured	37.13	0.086	17.21	0.569	113.83
BXHS-3A	5/10/2005	not measured	3.97	0.384	8.21	0.898	19.21
BXHS-3A	5/31/2005	not measured	11.57	0.106	6.61	0.640	39.91
BXHS-3A	7/6/2005	not measured	2.76	0.524	7.79	2.078	30.88
BXHS-3A	8/9/2005	not measured	4.17	0.461	10.36	0.390	8.77
BXHS-3A	10/20/2005	not measured	0.74	1.597	6.37	1.549	6.18
Growing Season median flow-concentration-loads			**4.069**	**0.423**	**8.00**	**0.769**	**25.05**
BXHS-4	3/23/2005	flow conditions too dangerous-ratio from BXHS-3A	83.26	0.073	32.76	0.617	277.04
BXHS-4	4/12/2005	55.2	55.2	0.069	20.53	0.439	130.50
BXHS-4	5/11/2005	5.9	5.9	0.154	4.90	0.609	19.38
BXHS-4	6/9/2005	17.2	17.2	0.085	7.88	0.553	51.31
BXHS-4	7/6/2005	4.1	4.1	0.486	10.74	1.889	41.76
BXHS-4	8/9/2005	6.2	6.2	0.223	7.45	0.445	14.88
BXHS-4	10/20/2005	1.1	1.1	0.751	4.45	1.415	8.39
Growing Season median flow-concentration-loads			**6.050**	**0.189**	**7.67**	**0.581**	**30.57**

* If instream flow was not measured on day of sample collection for a station, then a flow was estimated using drainage area ratio method

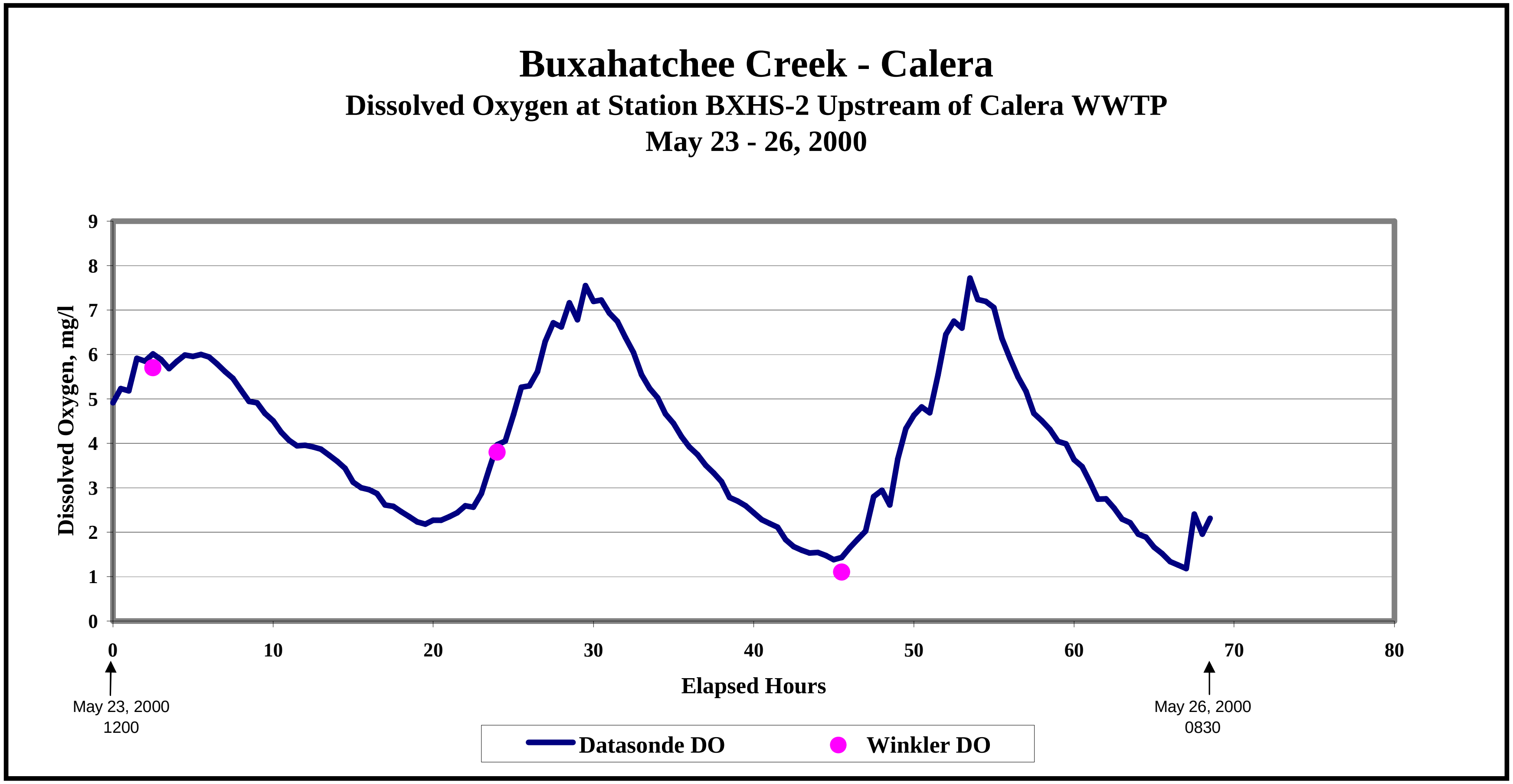
** If stream flow was measured during sample collection then that flow was used to calculate load. If stream flow was not measured then a ratioed flow was used to calculate loads.

Calera WWTP DMR Data

Parameter	DMR Month	Flow monthly average (mgd)	Flow monthly average (cfs)	Total P monthly average (mg/l)	Total P monthly average (lbsday)	Total N monthly average (mg/l)	Total N monthly average (lbs/day)
FLOW	2005/03	1.94	3.01	0.68	11.019	3.33	54.0
FLOW	2005/04	2.52	3.90	0.56	11.769	2.67	56.1
FLOW	2005/05	1.57	2.43	1.3	17.022	2.92	38.2
FLOW	2005/06	1.70	2.62	0.96	13.579	2.05	29.0
FLOW	2005/07	1.55	2.40	10.25	132.587	2.27	29.4
FLOW	2005/08	1.35	2.09	11.28	126.907	1.963	22.1
FLOW	2005/09	1.14	1.76	16.39	155.693	1.77	16.8
FLOW	2005/10	1.10	1.70	17.31	158.802	1.93	17.7
Growing Season median flow-concentration-loads		**1.55**	**2.40**	**10.25**	**126.91**	**2.05**	**29.0**

303(d) Physical Data						
Station Number	Date	Biological Indicators2	Biological Indicators3	Biological Indicators1	Biological Indicators4	Comments
BXHS-001	5/25/00					Low head dam present; dam exposed. Steram flowing around edge of dam. Stream flow minimal. No PC/HA, no field parameters, no stream flow taken.
BXHS-001	8/24/00	Fish	Filamentous	Periphyton		No flow. Creek consists of one stagnant pool.
BXHS-002	11/2/00	Fish	Filamentous	Periphyton		One large pool due to beaver-dam construction. Bottom sediments black; anaerobic conditions are a remnant of past problems with the WWTP
BXHS-002	6/21/00	Macrophytes	Fish	Periphyton	Filamentous	
BXHS-003	8/24/00	Macrophytes	Fish	Periphyton	Filamentous	Flow very slow. Power line right-of-way affects this reach.
BXHS-003	11/2/00	Macrophytes	Fish	Periphyton		Heavy impact from petroleum-contaminated sludge from Calera WWTP. Black-colored sludge layered on bottom of stream.
BXHS-003	6/21/00	Macrophytes	Fish	Periphyton	Other	Algal bloom present, possibly due to recent removal of 4-ft. beaver dam. Odor of water and sediment may be due to this event. Odor is that found in eutrophic conditions.
BXHS-004	5/25/00	Macrophytes	Fish	Periphyton		
BXHS-004	8/24/00	Macrophytes	Fish	Periphyton	Filamentous	Large number of snails. Sand and gravel deposition. Scattered relic mussel shells.
WTNS-001	8/24/00	Macrophytes	Fish	Periphyton	Other	
WTNS-001	5/24/00	Fish		Macrophytes		

ADEM INTENSIVE SURVEY DATA



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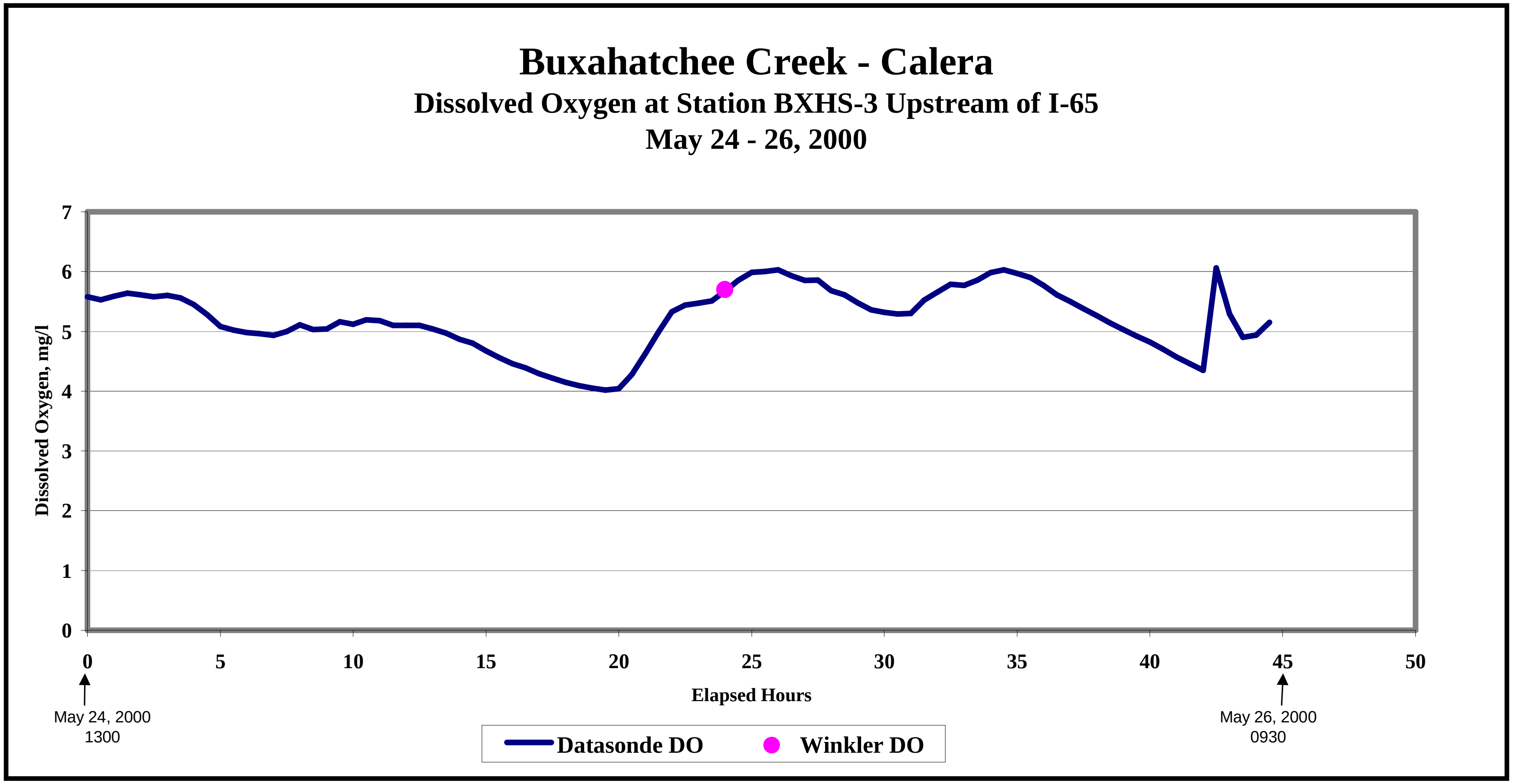

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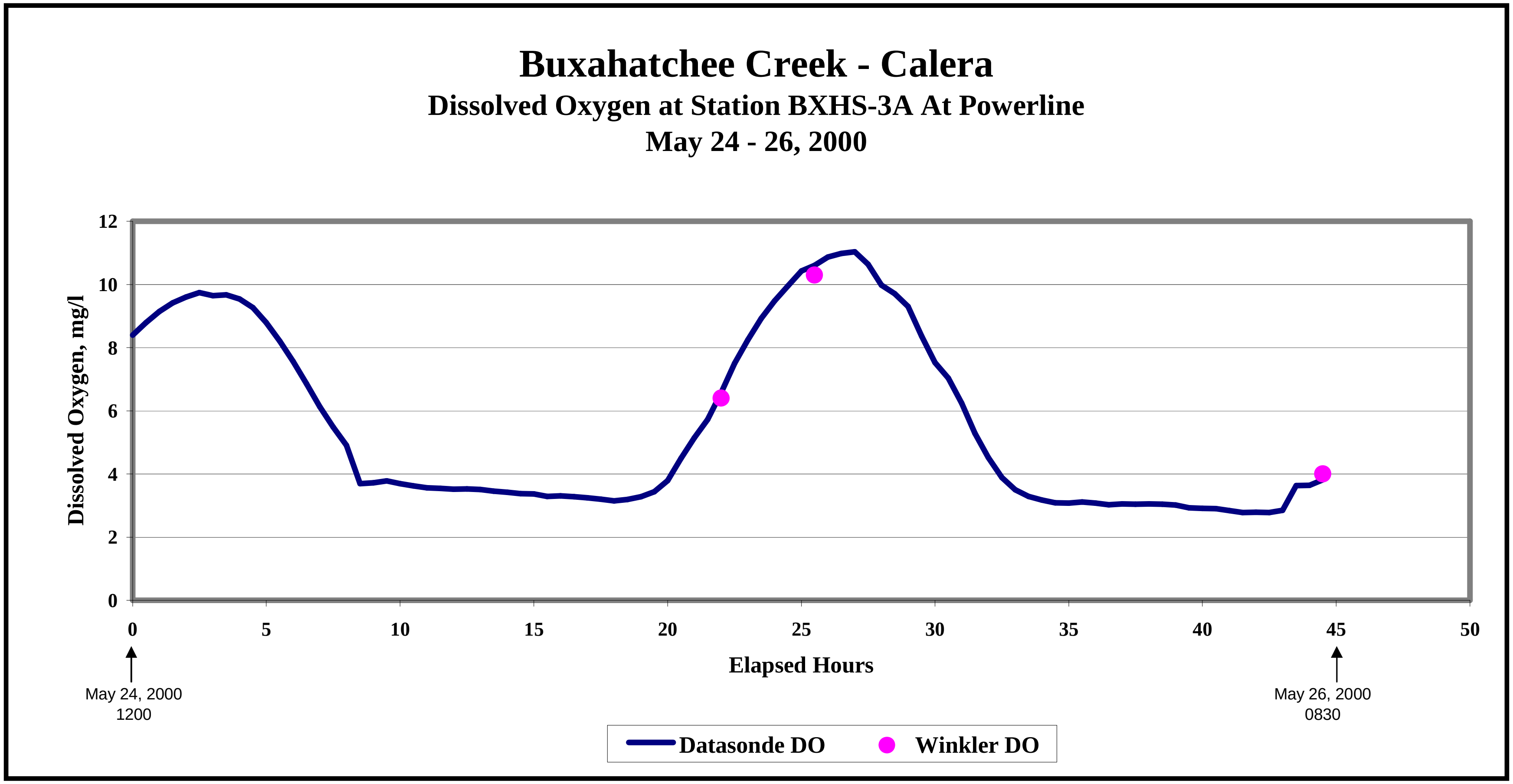

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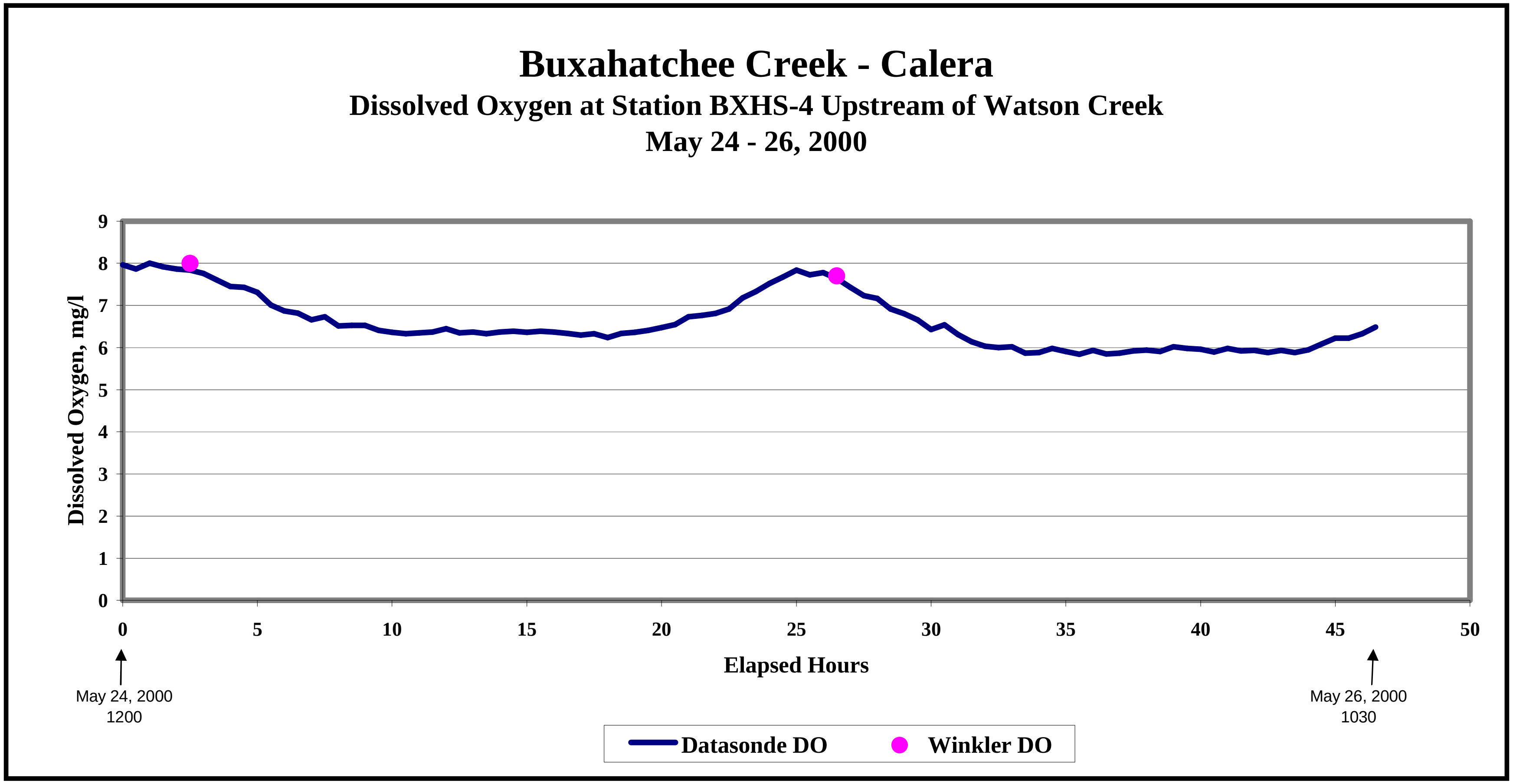

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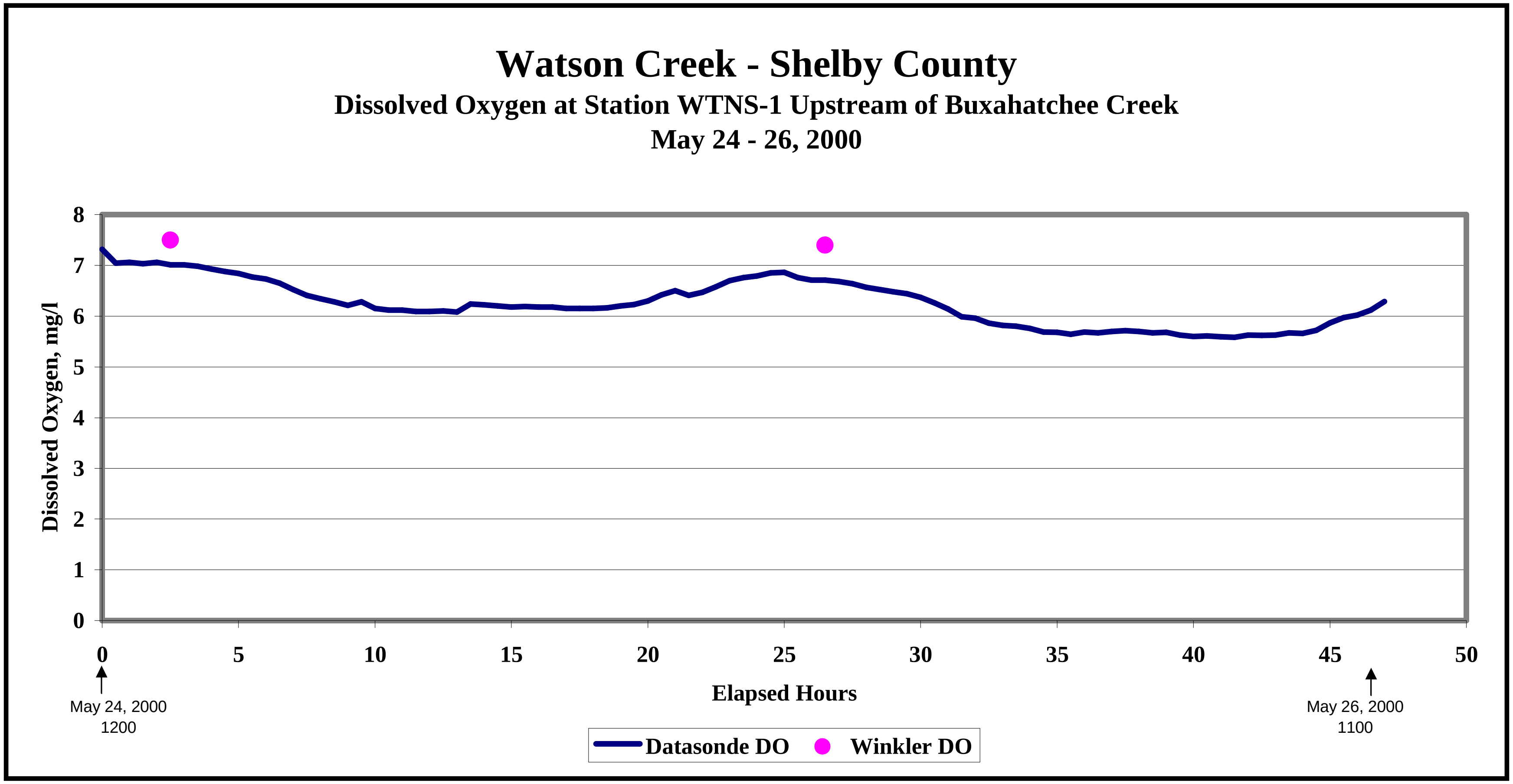

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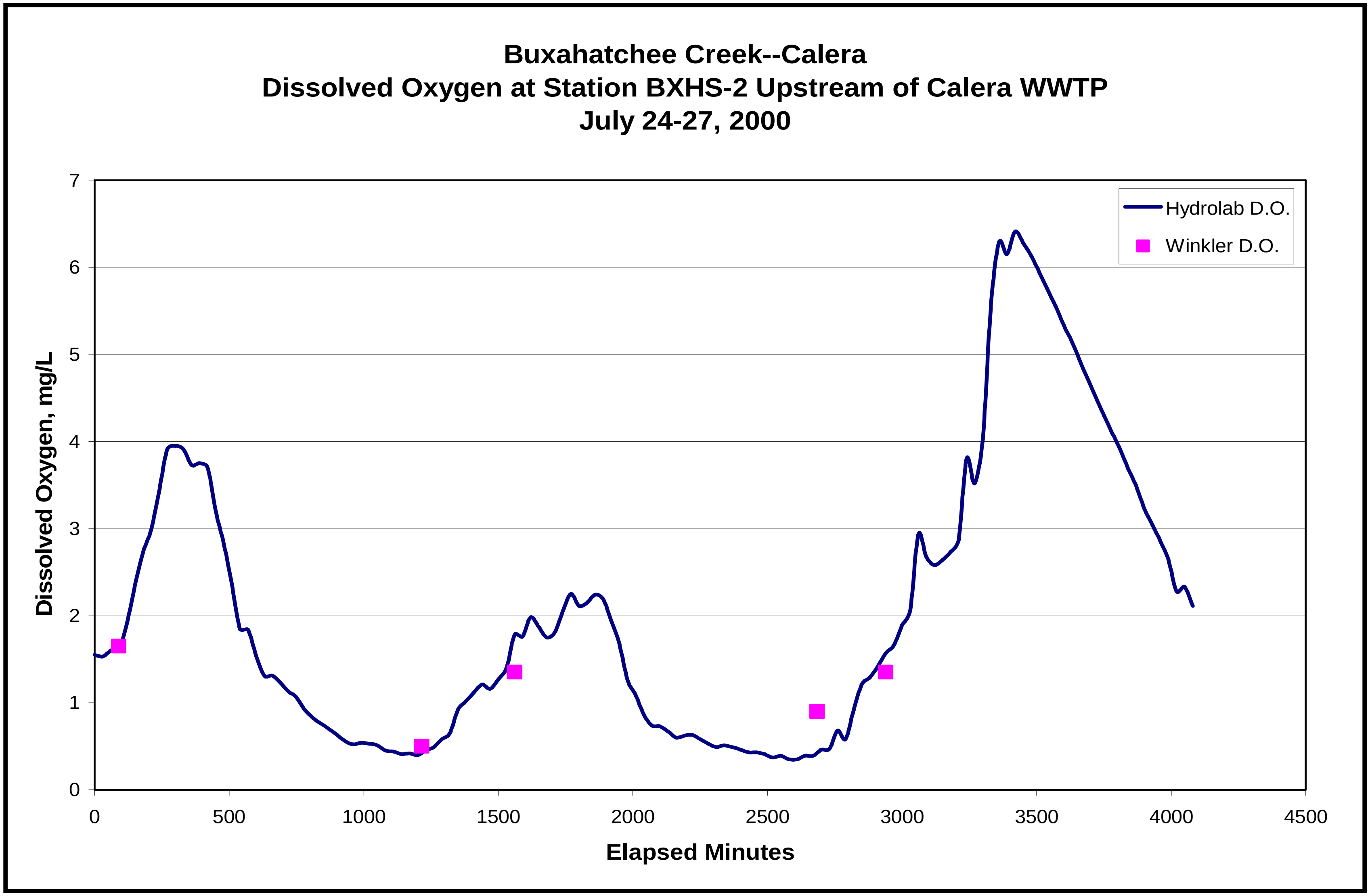

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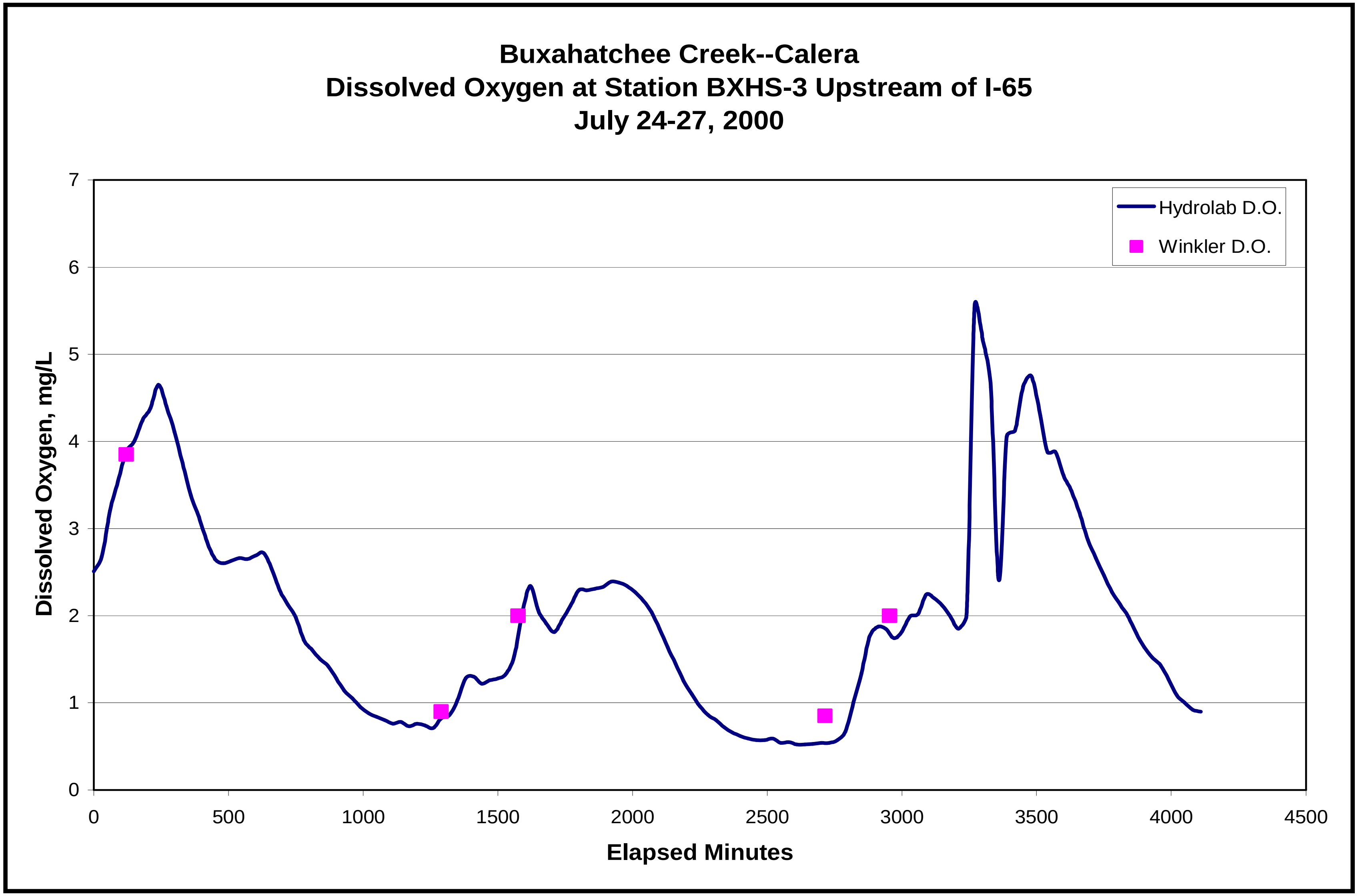

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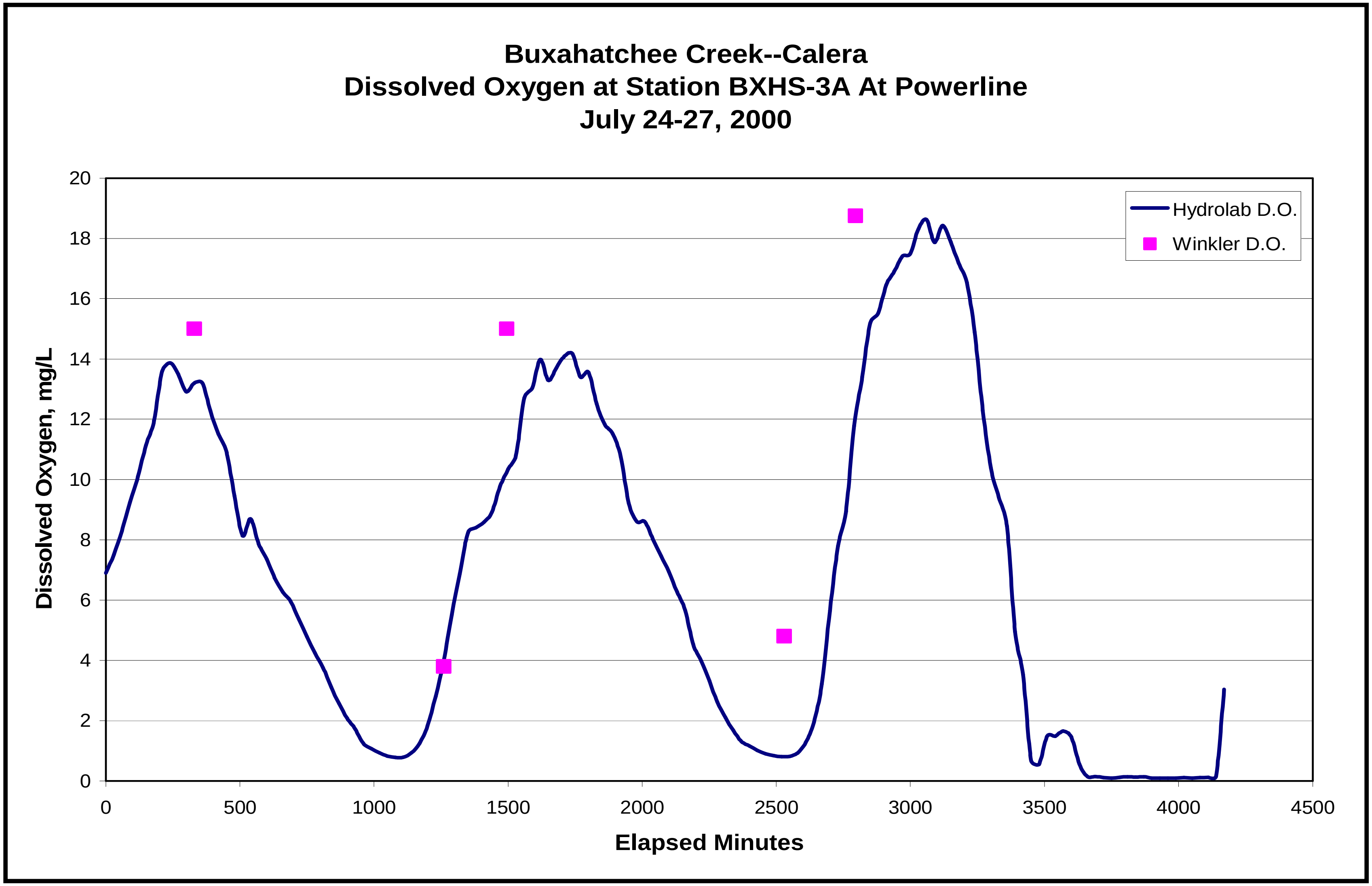

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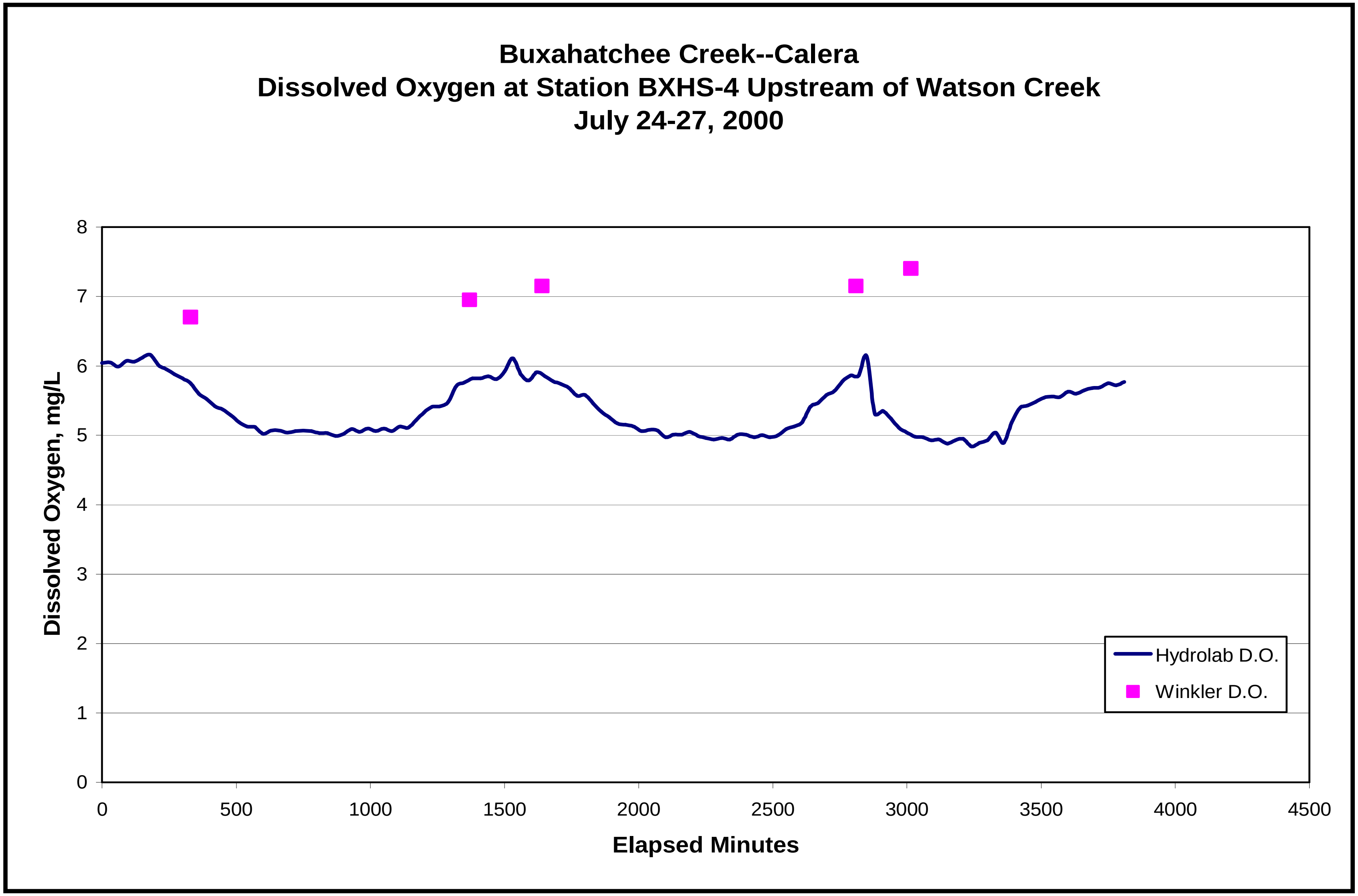

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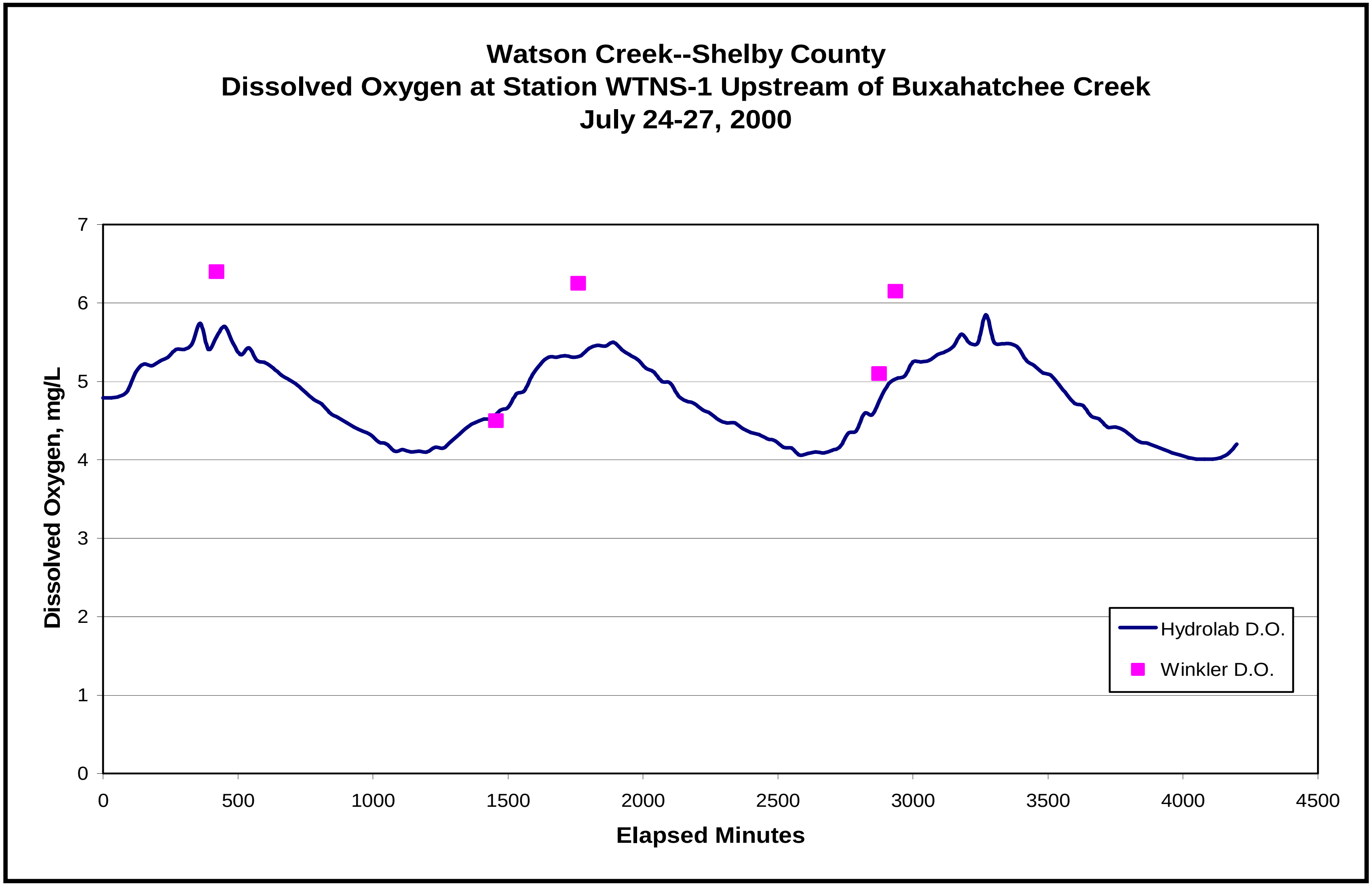
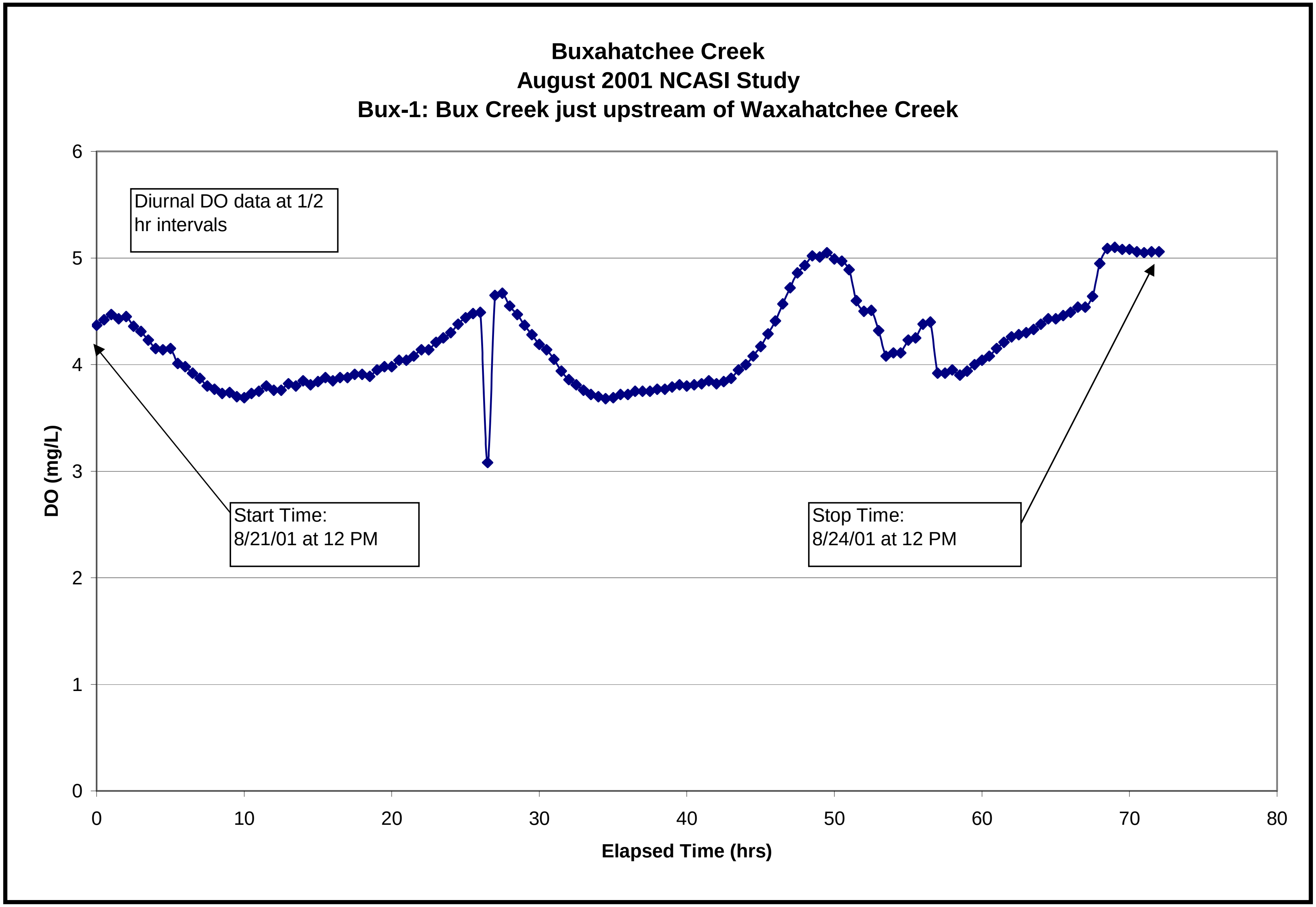
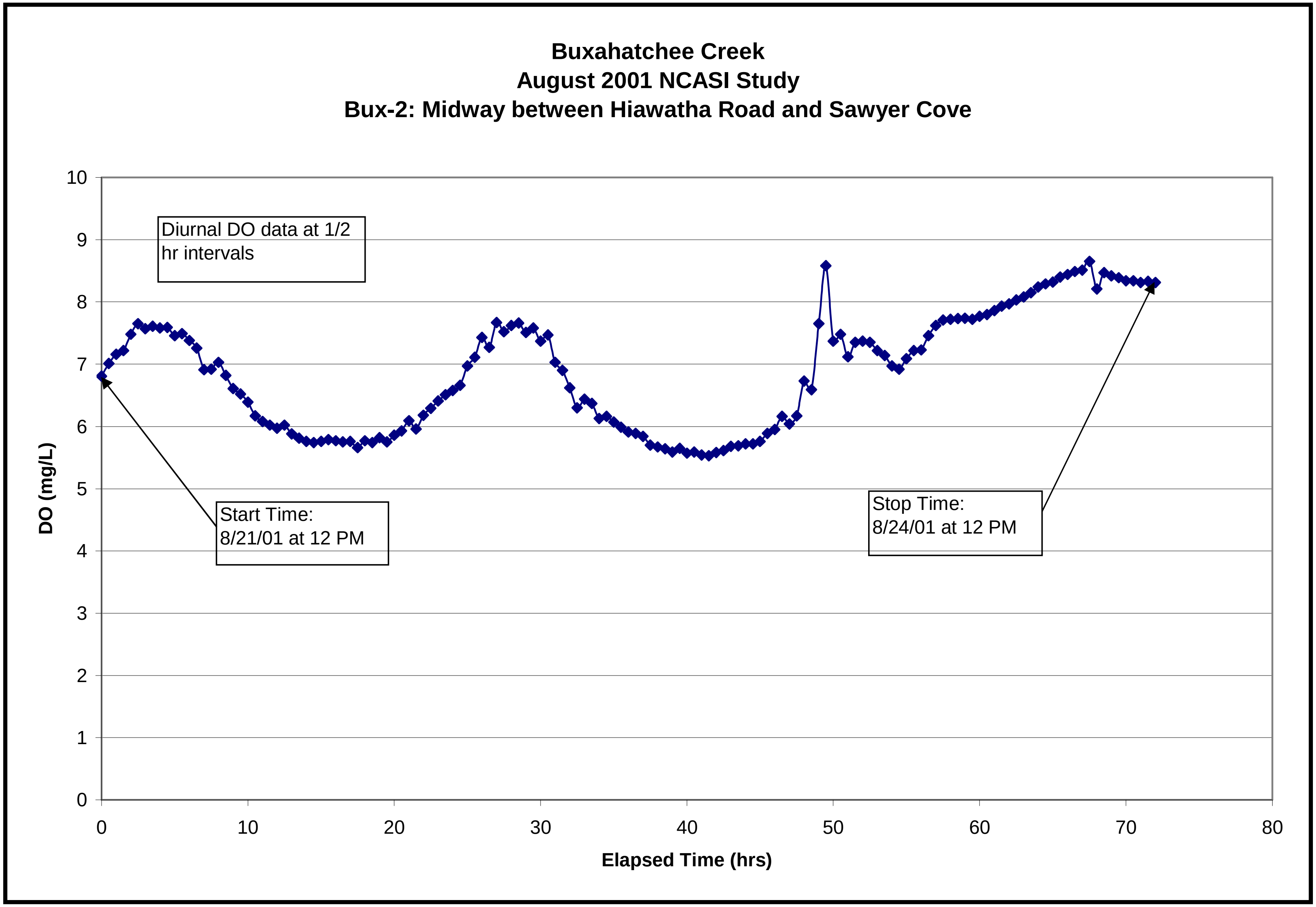


NCASI DATA


Buxahatchee Creek
August 2001 NCASI Study
Bux-1: Bux Creek just upstream of Waxahatchee Creek
Diurnal DO data at 1/2 hr intervals
Start Time: 8/21/01 at 12 PM
Stop Time: 8/24/01 at 12 PM
DO (mg/L)
0
1
2
3
4
5
6
0
10
20
30
40
50
60
70
80
Elapsed Time (hrs)

NCASI DATA (Continued)



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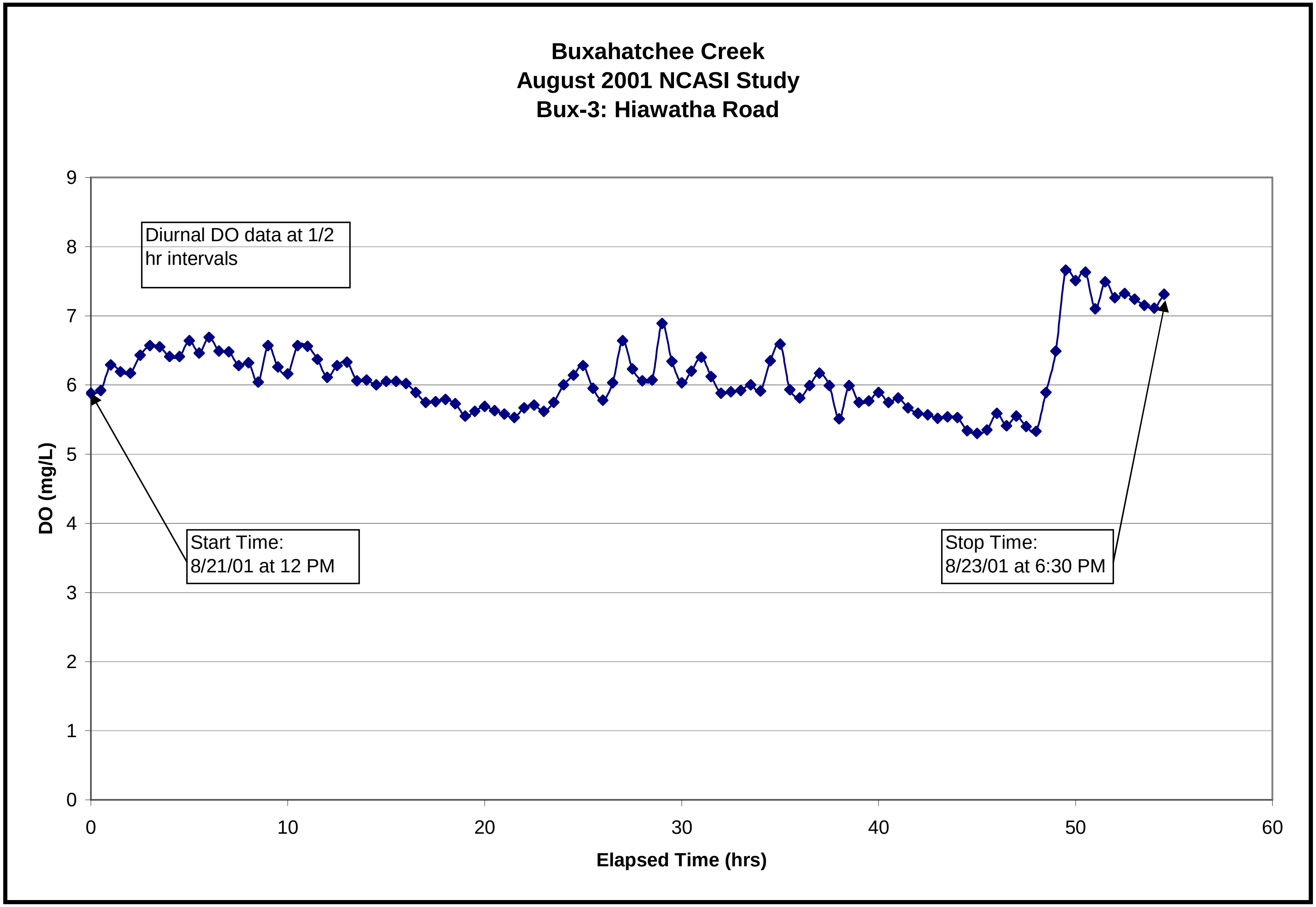

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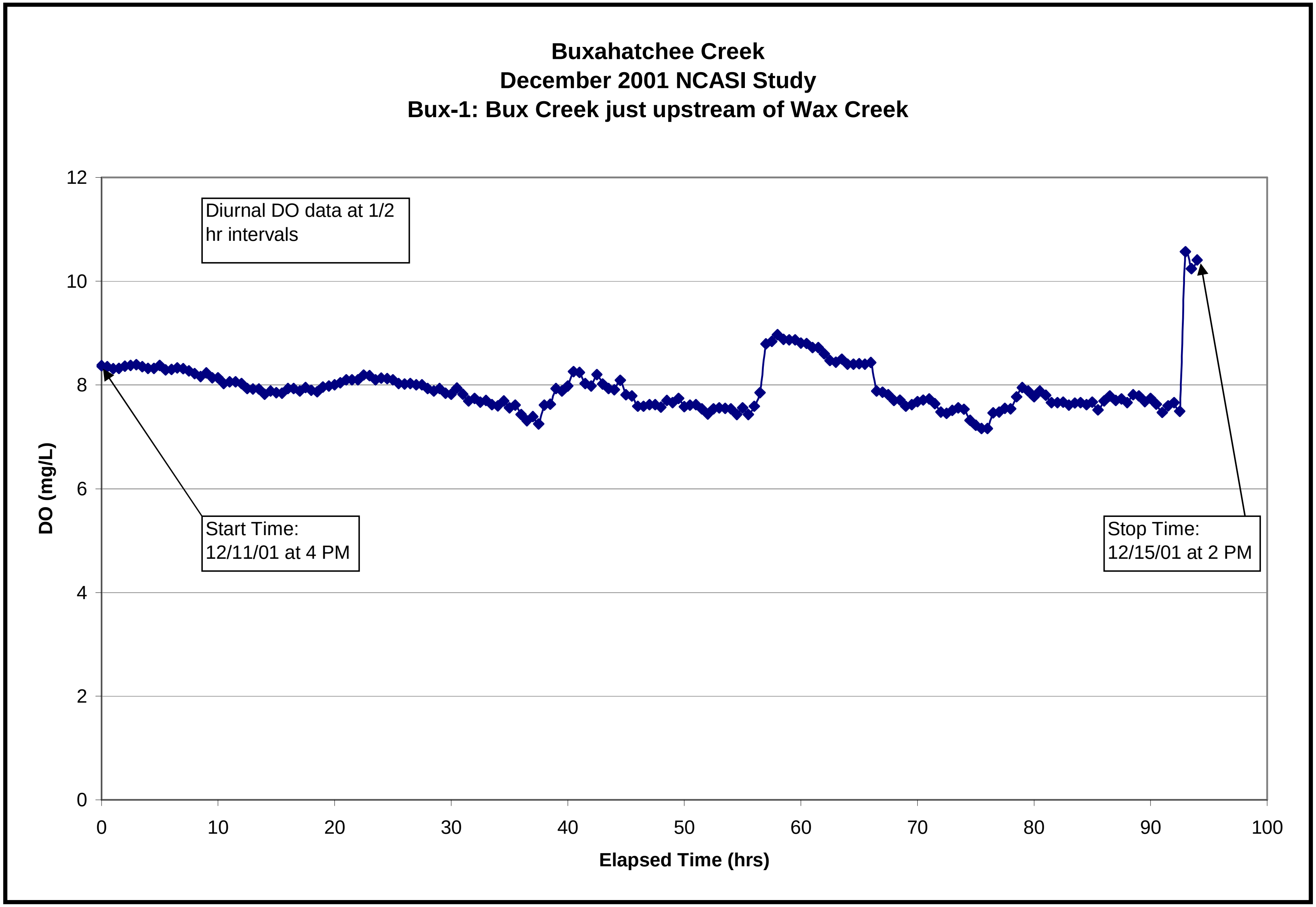

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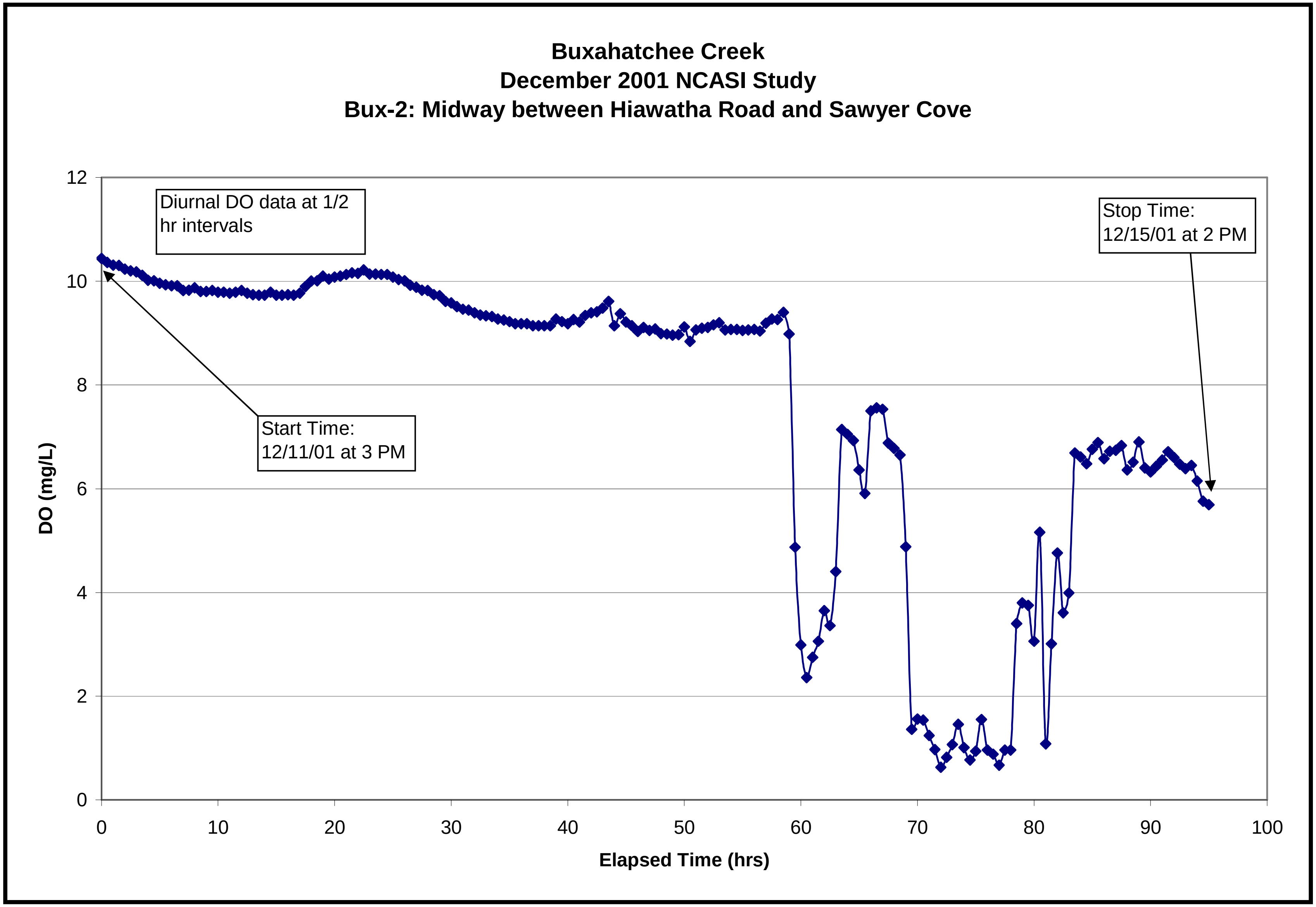

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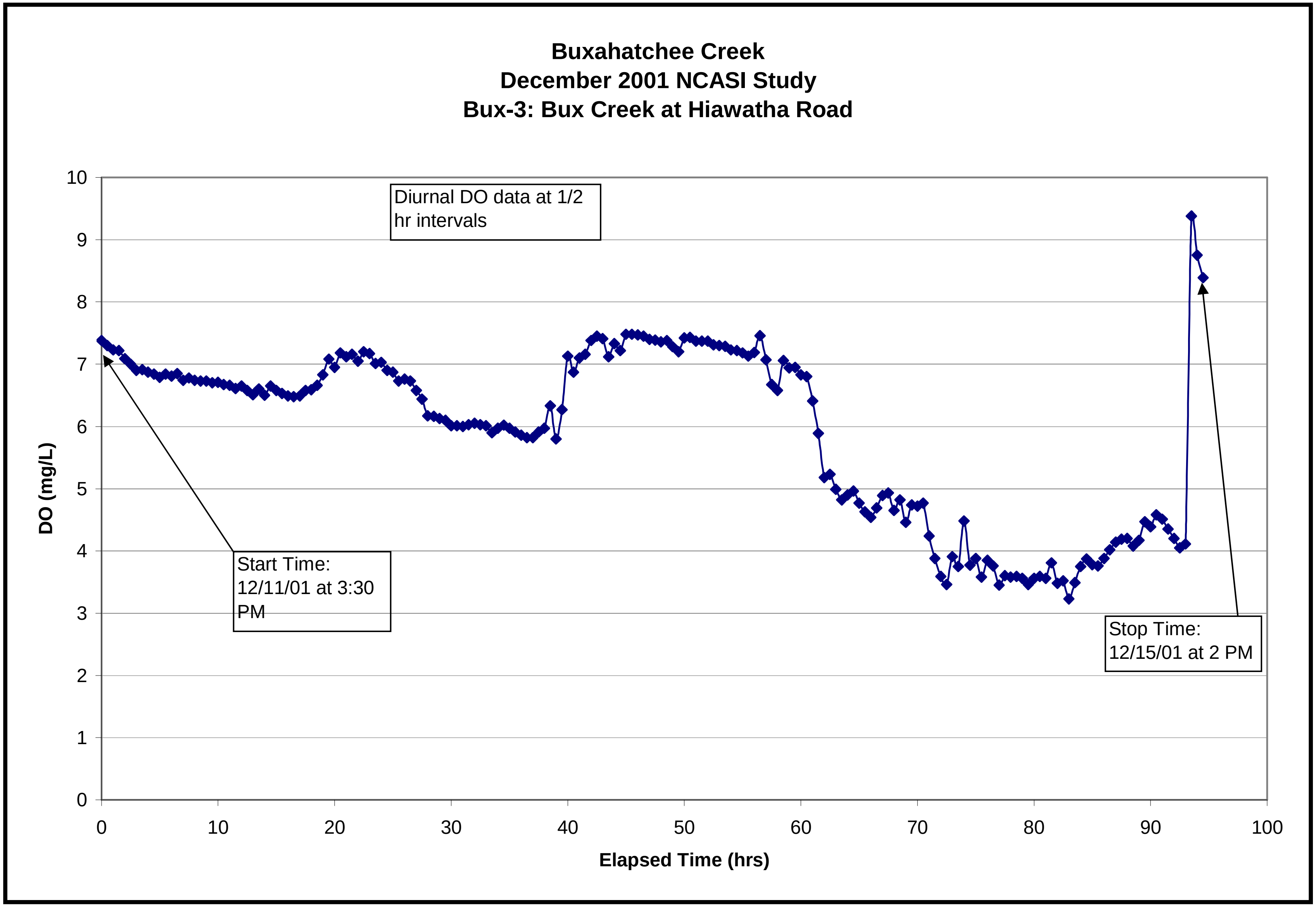

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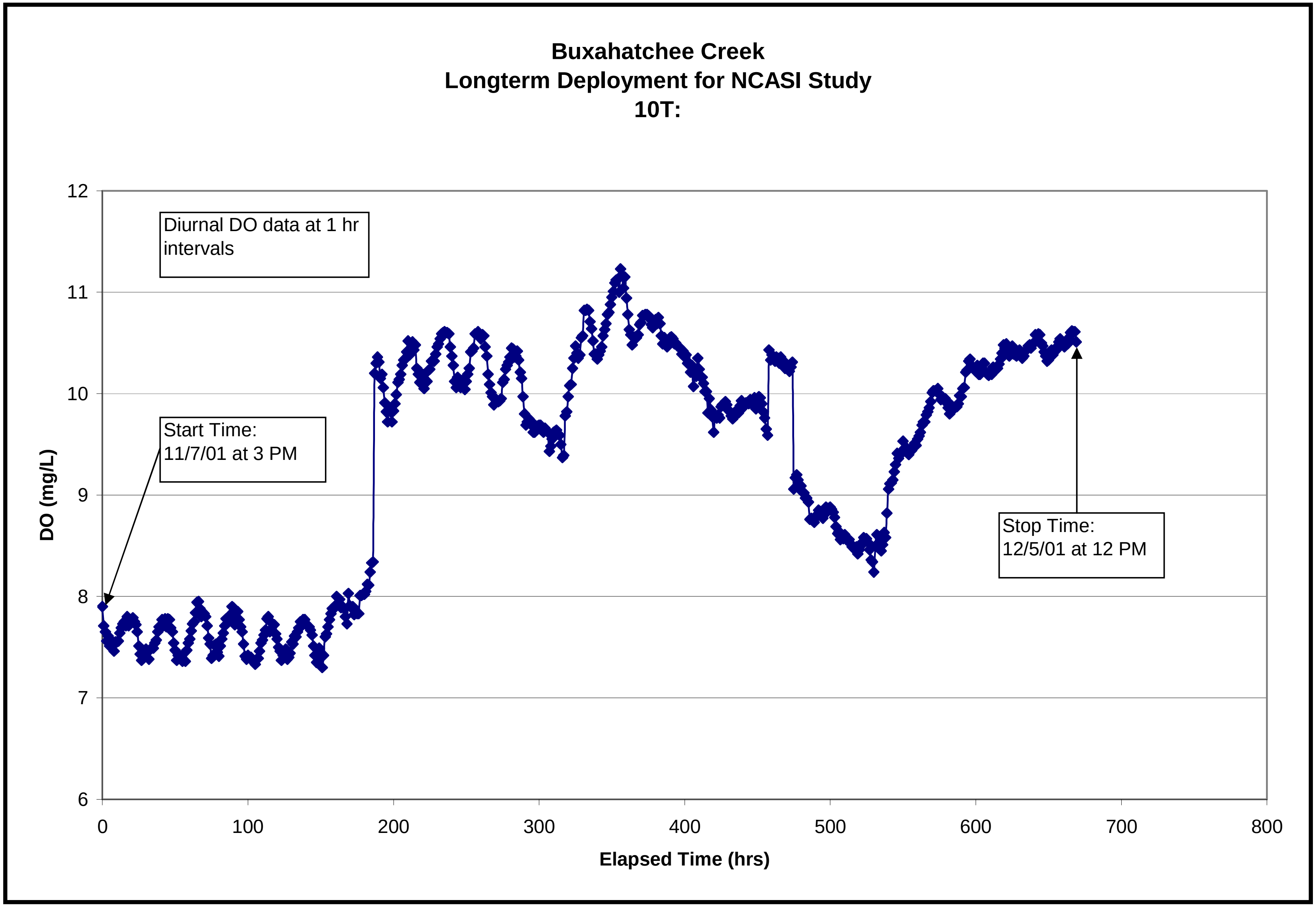

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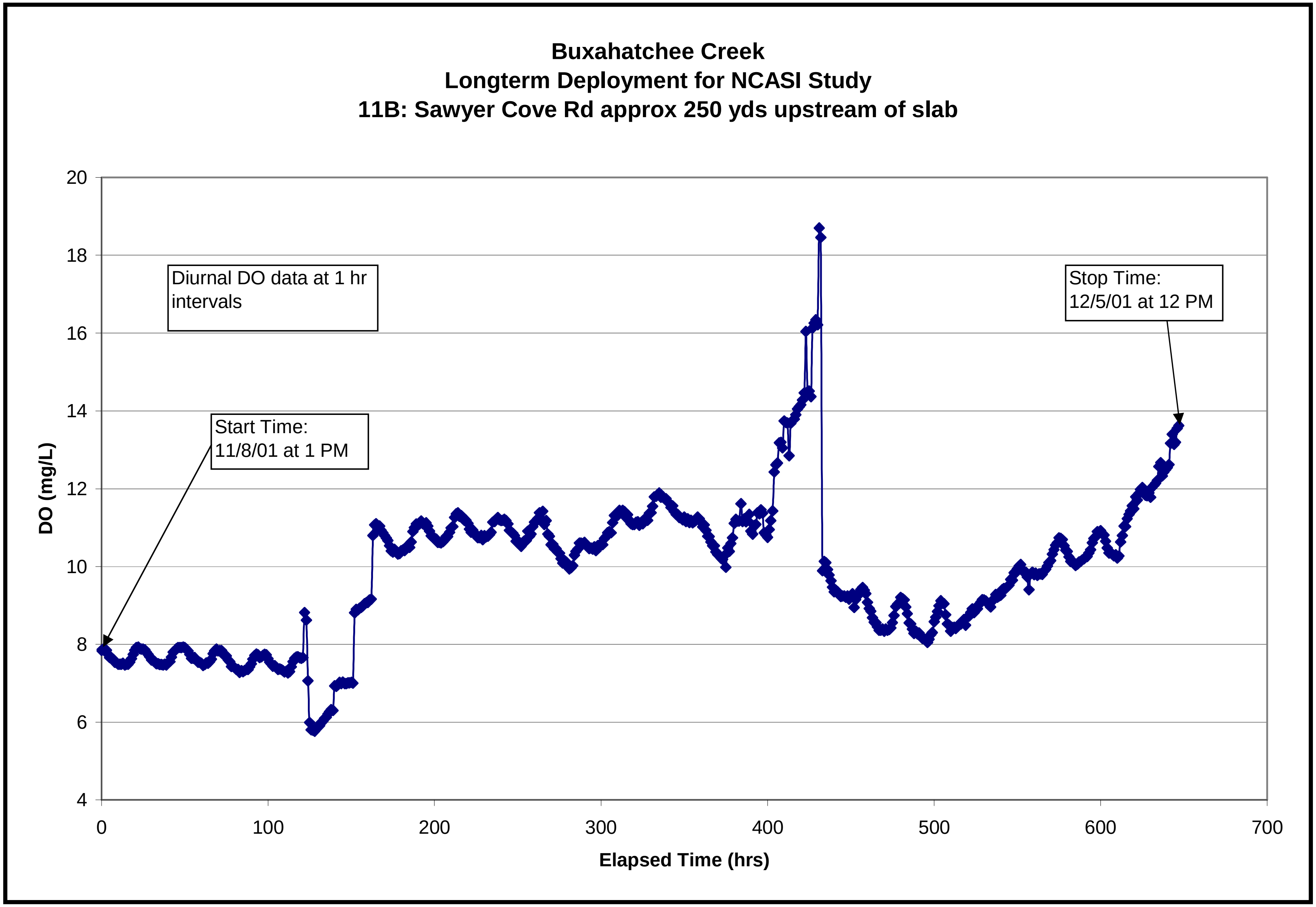

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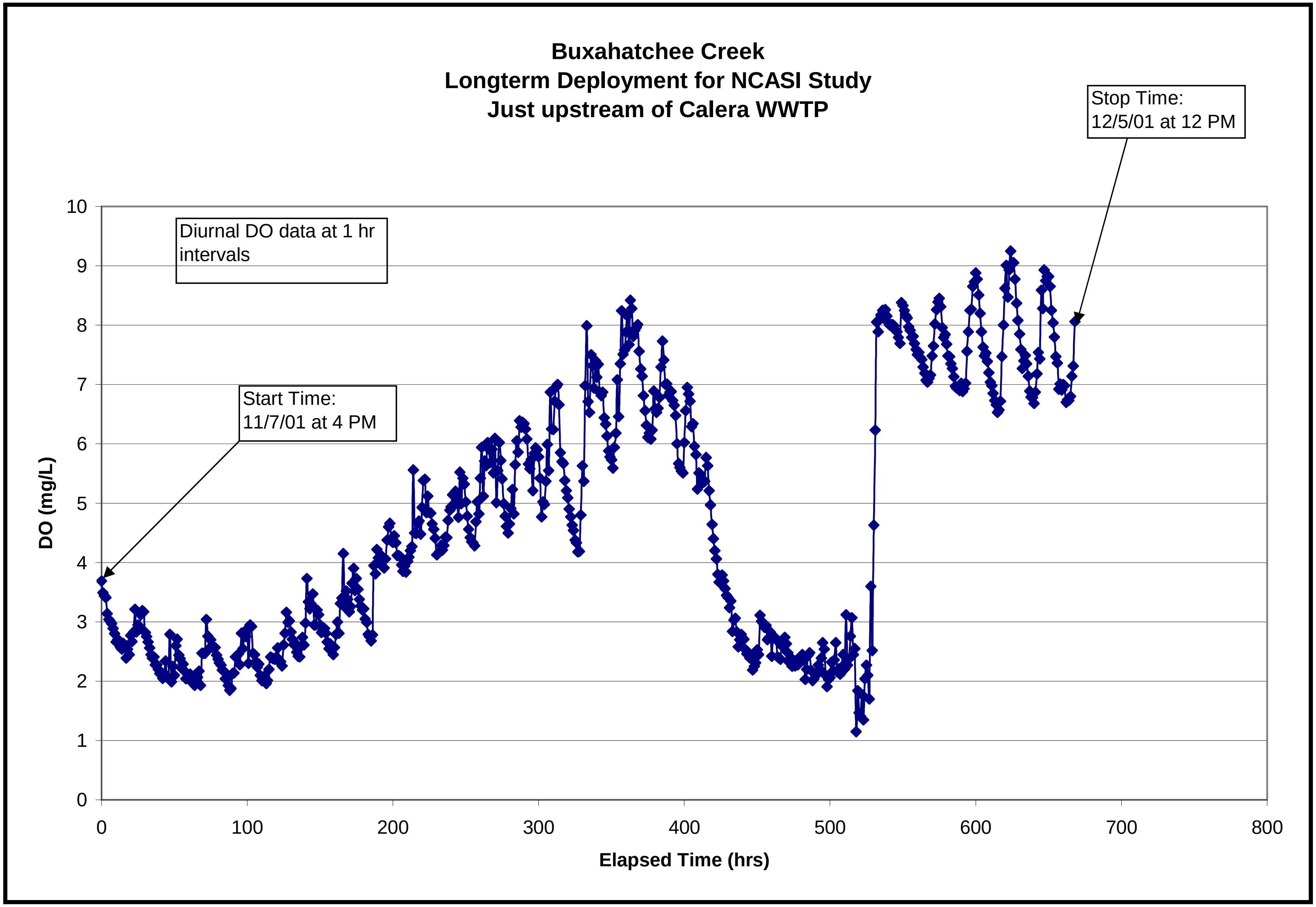

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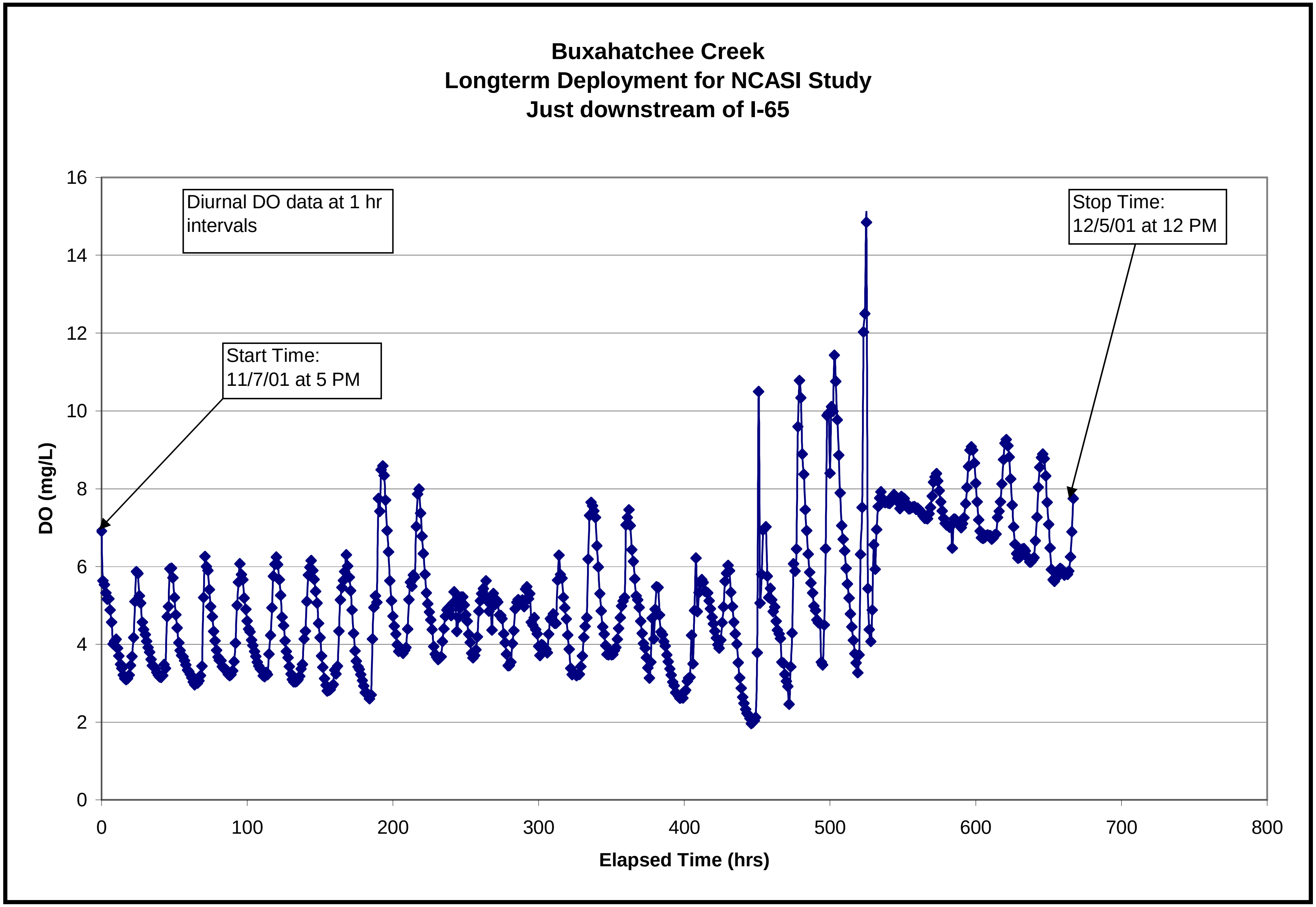

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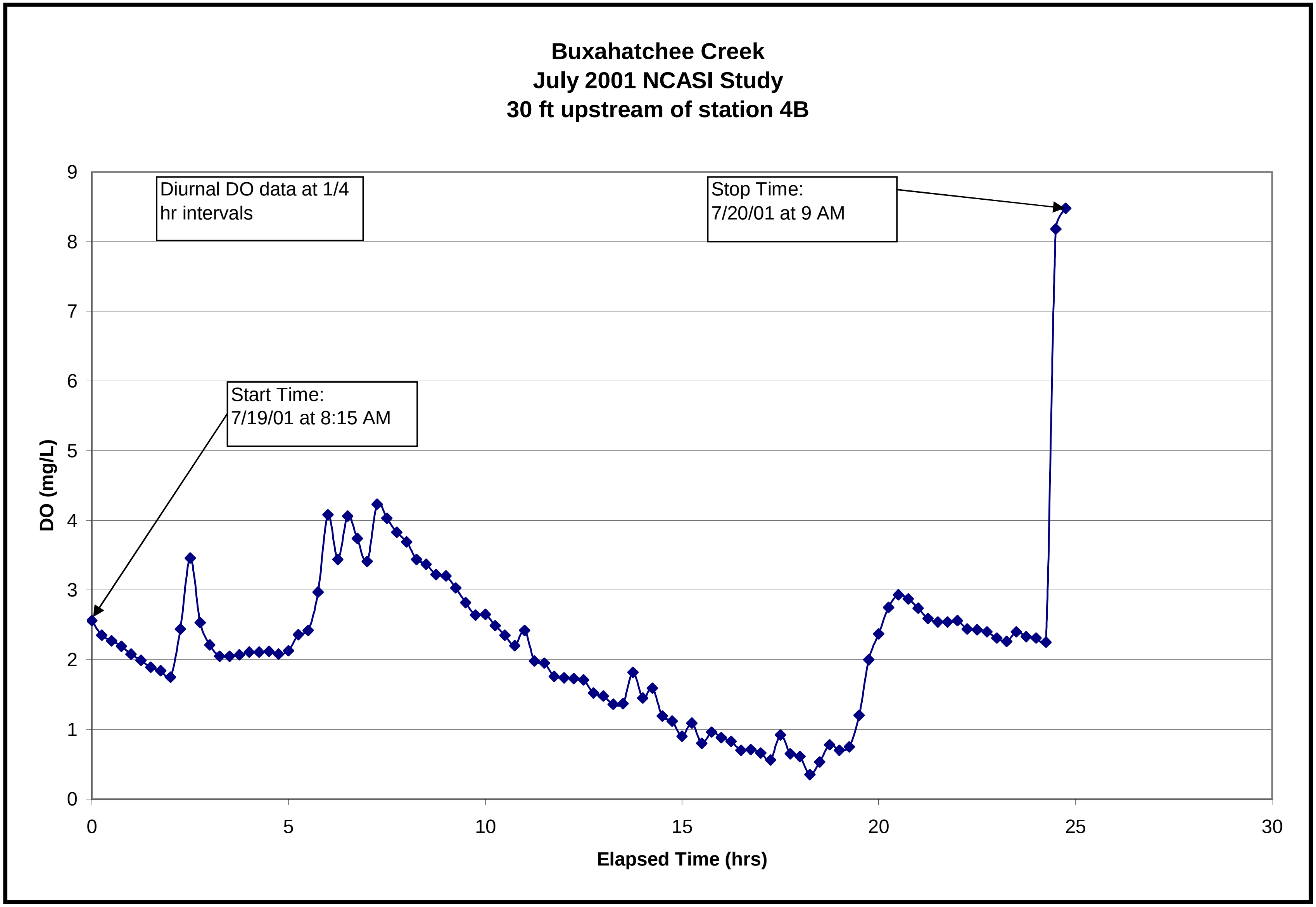

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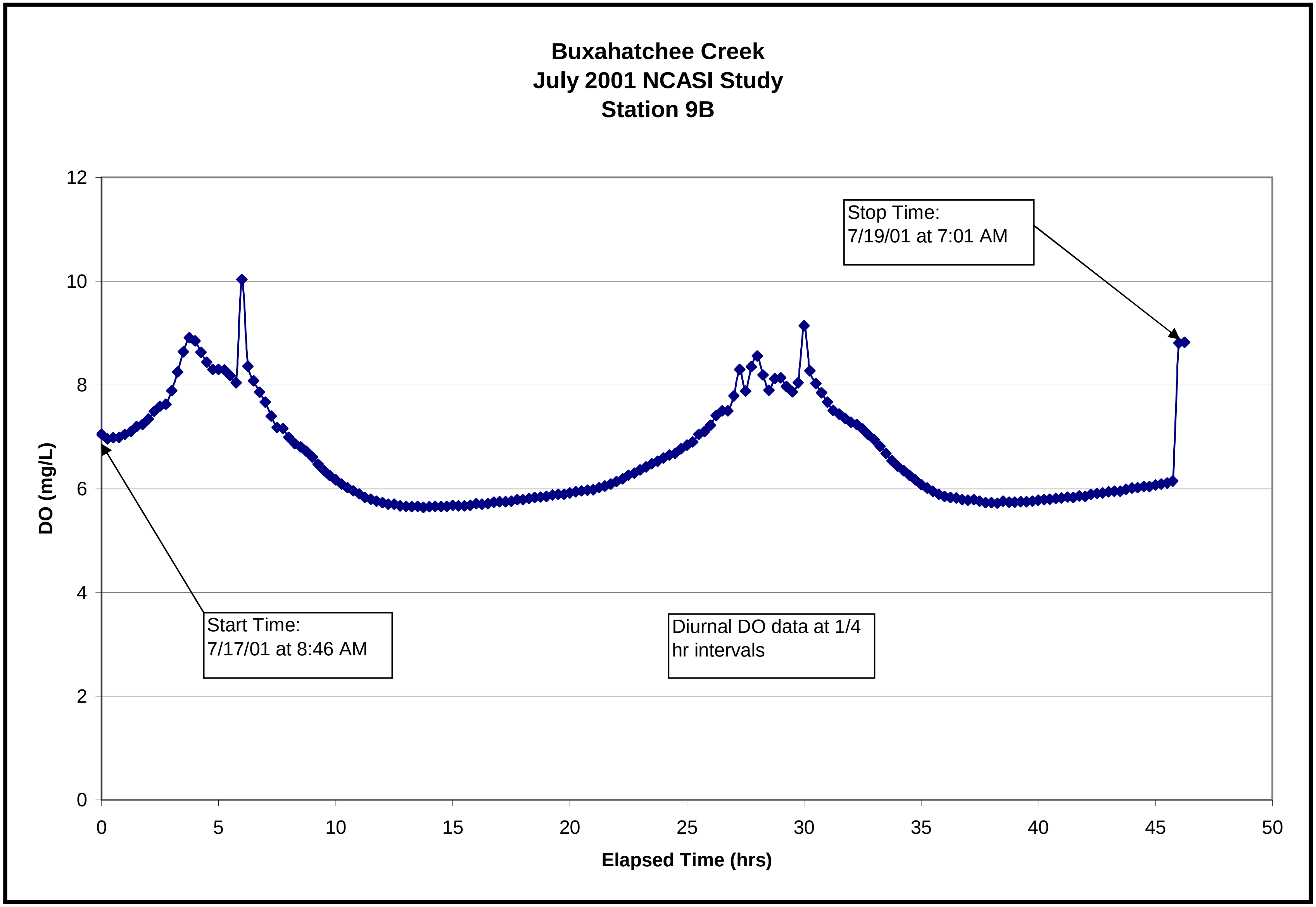

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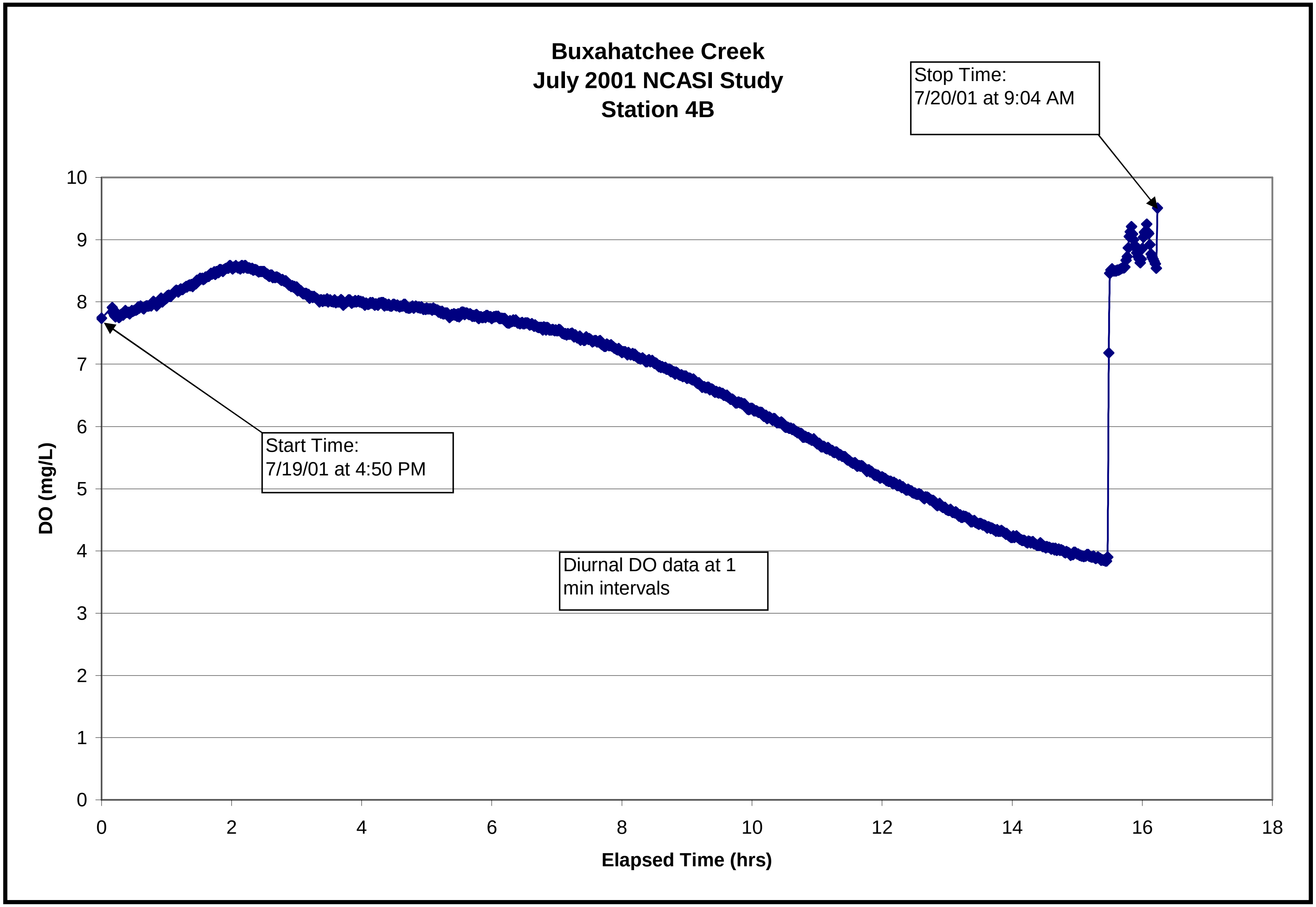

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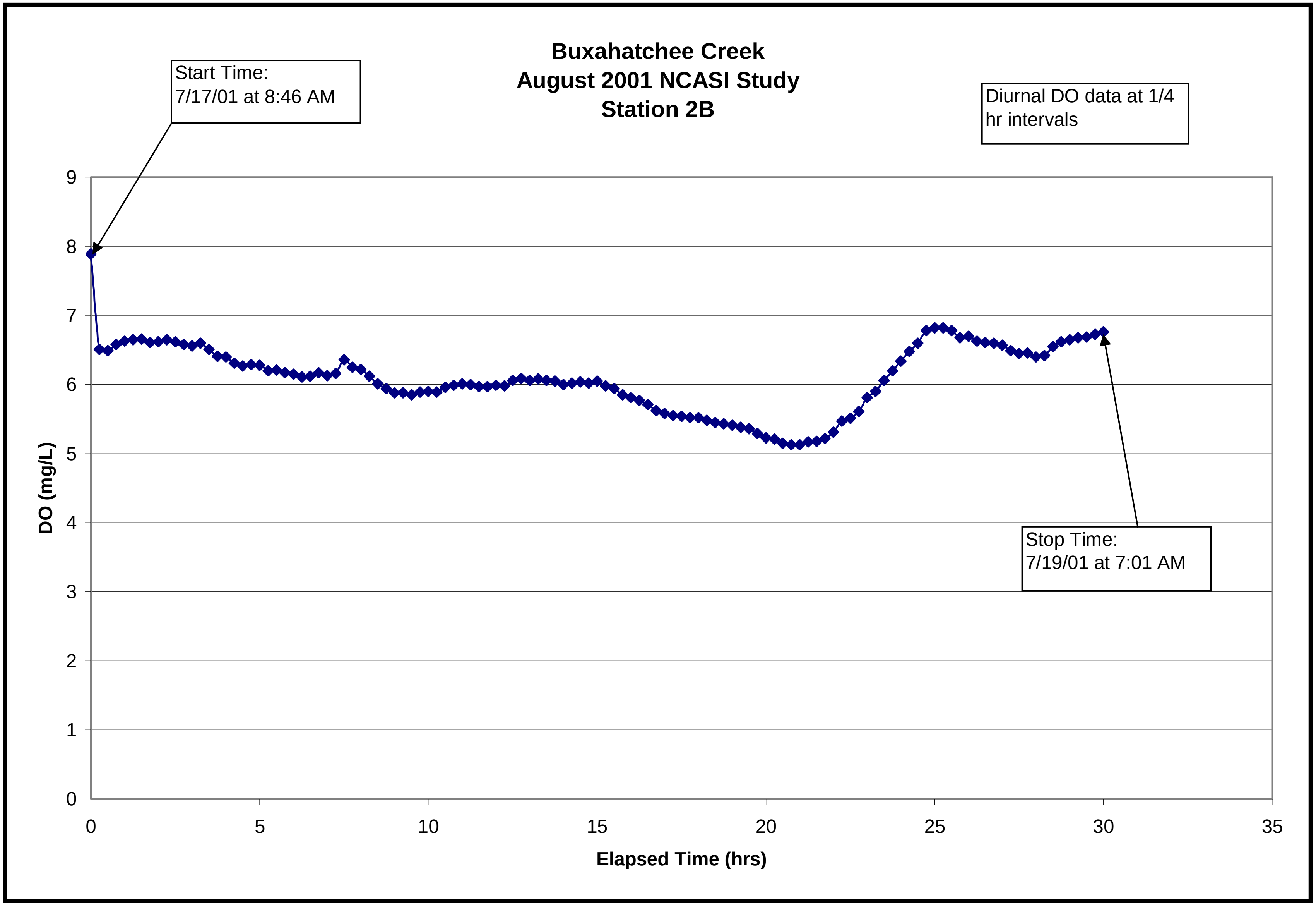

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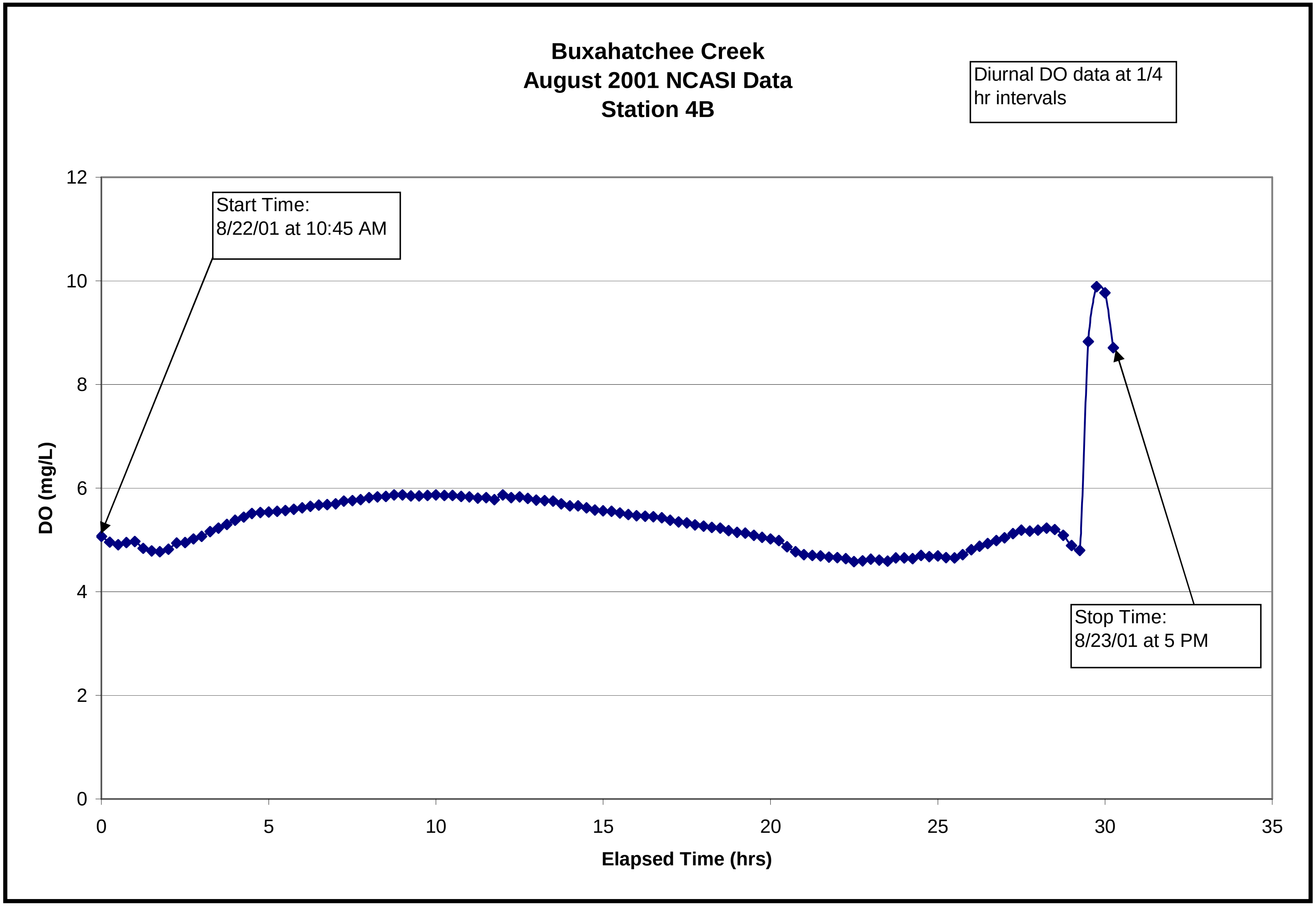

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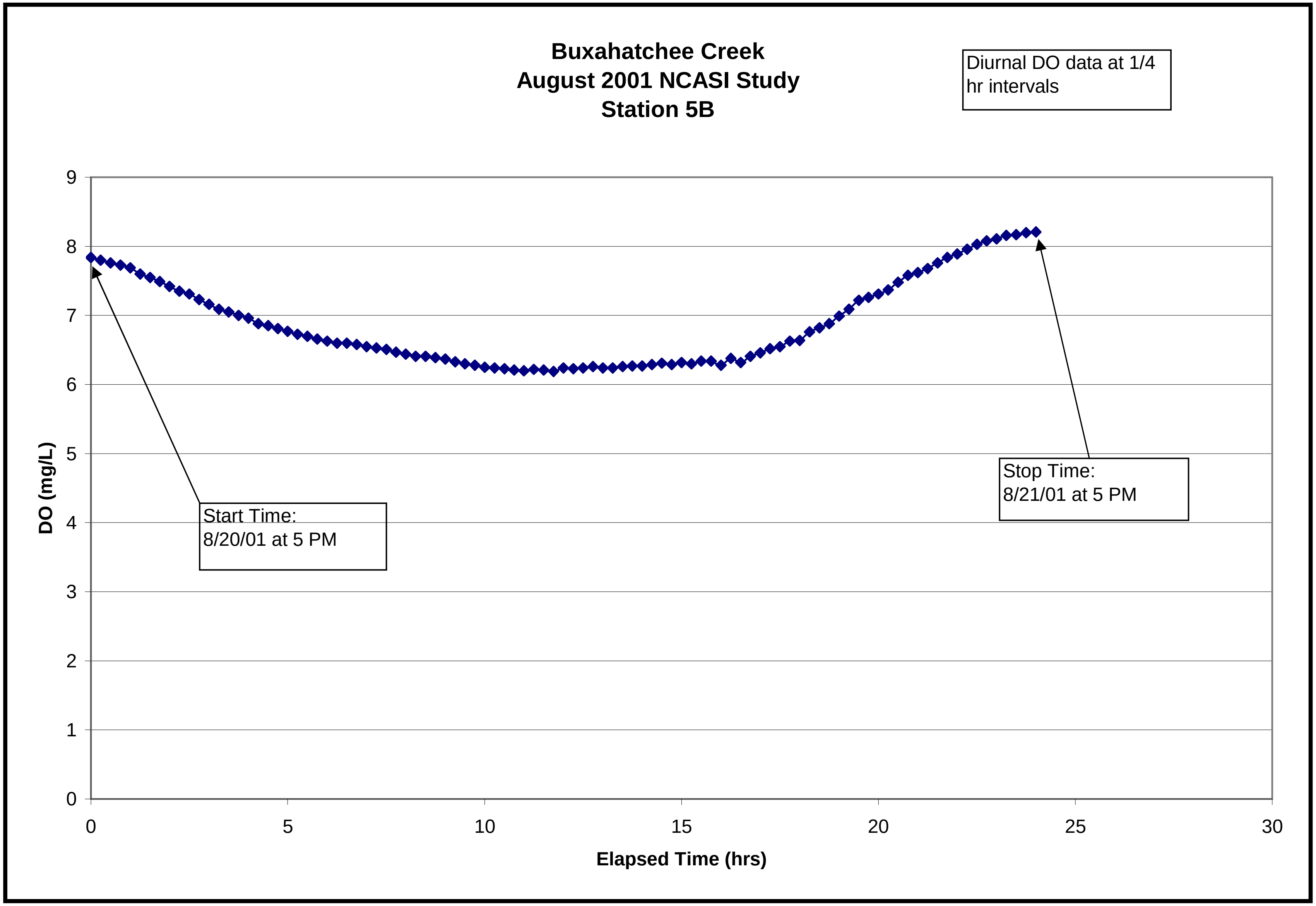

SOD Data from EPA

STATION	REP	DATE	TIME	UNADJ. D.O. RATE (mg/l/min)	ADJ. D.O. RATE (mg/l/min)	W. COLUMN RESP. (mg/l/min)	SOD** (gr O2/m2/d)	STND. DEV. (gr O2/m2/d)	CV (As Percent)
9B - Hiawatha Road	*1	9/25/2001		NA	NA				
	2		0922-1442	0.00489	0.00454		1.56200		
	3		0927-1442	0.00516	0.00481		1.65316		
	4		0932-1037	0.00515	0.00480		1.64945		
	0		0942-1437			0.00035			
	00		0957-1437			0.00035			
STA MEAN				**0.00380**	**0.00354**	**0.00035**	**1.21615**	**0.05159**	**4.24232**
4B - Timberline	***1	9/26/2001		NA	NA				
Golf Course	2		0932-1307	-0.00586	-0.00570		-1.96011		
	3		0937-1307	-0.00553	-0.00537		-1.84569		
	4		0937-1307	-0.00633	-0.00617		-2.12049		
	0		1012-1307			-0.00016			
	00		1017-1307			0.00037			
STA MEAN				**-0.00591**	**-0.00575**	**0.00011**	**1.97543**	**0.13804**	**6.98777**
2B - Calera	1	9/27/2001	0847-1117	0.00637	0.00566		1.94512		
WWTP D/S	2		0847-1127	0.00498	0.00428		1.47060		
	3		0847-1127	0.00422	0.00352		1.20825		
	4		0852-1127	0.00539	0.00469		1.61094		
	0		0852-1122			0.00071			
	00		0852-1122			0.00076			
STA MEAN				**0.00524**	**0.00454**	**0.00073**	**1.55873**	**0.30694**	**19.69142**
P1 - Calera	1	9/27/2001	1352-1602	0.02022	0.01983		6.81653		
WWTP U/S	2		1352-1607	0.01539	0.01500		5.15640		
	3		1352-1602	0.01666	0.01627		5.59204		
	4		1352-1607	0.01306	0.01267		4.35429		
	0		1347-1557			0.00039			
	00		1342-1557			0.00031			
STA MEAN				**0.01633**	**0.01594**	**0.00035**	**5.47982**	**1.02807**	**18.76107**

*SEAL ON CHAMBER WAS BREECHED. NO DATA WAS OBTAINED FROM CHAMBER 1.
** ADJUSTED FOR WATER COLUMN RESPIRATION
***PUMP ON CHAMBER MALFUNCTIONED. NO DATA WAS OBTAINED FROM CHAMBER 1.

Reaeration Data from Limno-Tech

Table 1. Buxahatchee Creek Reaeration Survey Location and Descriptive Information

	Upstream Reach (above I-65)	Downstream Reach (below I-65)
Survey Dates	9/12-13/02	9/11-12/02
Injection Point	River Mile 0.42 (at Calera, AL sewage treatment plant outfall)	River Mile 0.93 (below tributary from golf course (location 3T))
Upstream Sampling Station	River Mile 0.49 (336 ft d.s. of injection point)	River Mile 0.98 (254 ft d.s. of injection point)
Downstream Sampling Station	River Mile 0.66	River Mile 1.07
Estimated Average Surface Water Slope	0.0027 ft/ft	0.0019 ft/ft
Average Stream Width Range	Approx. 3-30 feet	Approx. 25-30 feet
Average Stream Depth Range	Approx. 0.3-3+ feet	Approx. 1.3-2.4 feet
Notable Characteristics	Variable depths and widths between riffles and pools, two 90 degree bends in stream, a small tributary and a beaver dam between sampling stations	Fairly uniform and straight channeled stream reach, no riffles, no obstructions, no tributaries in the reach

Table 1. Buxahatchee Creek Reaeration Survey Results

	Upstream Reach Survey 9/12-13/02		Downstream Reach Survey 9/11-12/02	
	Upstream Station	Downstream Station	Upstream Station	Downstream Station
Time of Travel to Dye Peak (min)	70	635	172	477
Peak Dye Concentration (ug/L)	320.6	31.3	154.5	36.6
Peak Propane Concentration (ug/L)	97	2.3	24	1.9
Dye Recovery Ratio*	0.86	0.88	0.95*	0.80*
Propane Gas Desorption Rate Coefficient between Stations (1/hr)*	0.15		0.20	
Stream Reaeration Rate Coefficient (at 20^{o}C) between Stations (1/hr)*	0.18		0.25	

* Results using literature values for Recovery Ratio

Appendix C

2005 Buxahatchee Creek Report

Results of Macroinvertebrate and Periphyton Community Assessments

3 October 2006

**Environmental Indicators Section –
Field Operations Division**

Background

Buxahatchee Creek, a tributary of the Coosa River basin, drains approximately 70 mi^2 in Chilton and Shelby Counties. A 13-mile segment of Buxahatchee Creek has been included on Alabama's biennial §303(d) lists since 1996 for impairments caused by nutrient enrichment. Municipal and urban runoff/storm sewers were identified as the sources of the impairment on the 2000 §303(d) list.

Objectives

At the request of the Water Quality Branch of ADEM's Water Division, macroinvertebrate community bioassessments were conducted at three segments of Buxahatchee Creek. The objectives of these assessments were twofold:

1. To assess the condition of the macroinvertebrate communities in Buxahatchee Creek using ADEM's intensive-level macroinvertebrate bioassessment (MB-I) method; and,
2. To provide baseline macroinvertebrate bioassessment data that can be used to measure any changes in water quality due to development and implementation of Total Maximum Daily Load(s) (TMDL).

Methods

Buxahatchee Creek 2005 Assessment Database: To assist with data analysis and reporting, all information and data associated with the 2005 Buxahatchee Creek assessment was compiled into one ACCESS database. The five tables contain all field parameters, chemical samples, and habitat assessment results. The four forms can be used to view and print station descriptions, requested parameters and sampling frequency, Habitat Assessment/Physical Characterization information, and results of laboratory analyses.

Station Locations: Water samples were requested at two stations upstream and five locations downstream of the Calera WWTP outfall. Samples could not be collected at BXHS-1, the most upstream station, however, due to a lack of flow. Samples could also not be collected at BXHS-5 and BXHS-6, the two downstream-most locations.

Water quality sample collection: Field parameters, flows, and intensive water quality sampling was conducted March, April, May, July, and August at BXHS-2, BXHS-3, BXHS-3A, and BXHS-4. Samples were also collected during June and October at BXHS-4. At the request of ADEM's Director, samples were not collected during September due to the gasoline shortage caused by Hurricane Katrina. Duplicate field parameters were collected during 10% of the sampling events. Duplicate water quality samples were collected during 5% of the sampling events.

Chemical analyses of water samples were conducted by ADEM's Central Laboratory in Montgomery. Water quality samples for laboratory analysis were collected, preserved, and transported to ADEM's Laboratory as described in ADEM Field Operations Standard Operating Procedures and Quality Control Assurance Manual, Volume I - Physical/Chemical (ADEM 2000c). Laboratory analyses were conducted in accordance with ADEM's Quality Assurance Manual for the Alabama Department of Environmental Management Central Laboratory (ADEM 1999d).

Sample handling and chain-of-custody procedures were used for all biological and chemical samples as outlined in ADEM Field Operations Standard Operating Procedures and Quality Control Assurance Manual, Volumes I and II to ensure the integrity of all samples collected (ADEM 1999a, 2000c).

Water Quality Assessment guidelines: The four Buxahatchee Creek stations are located within the Piedmont (45a) and Ridge and Valley (67g) ecoregions. Median and average values of water quality parameters were assessed as *exceeding* or *not exceeding* background levels as defined by the 90th percentile of data collected at least-impaired ecoregional reference reaches within that subecoregion from 1991-2001 (ADEM 2004a). The 5th and 95th percentile were treated as outliers and removed before analysis. These values are provided in Table 1.

Table 1. Ecoregional reference guidelines (90th percentile of ecoregional reference reach data minus 5th and 95th percentiles)

Subecoregion	67g					45a	
	Final 90th	**Final N**	**Min**	**Max**	**Median**	**Final 90th**	**Final N**
F COL (col/100ml)	360	17	41	1110	130	573	20
Chl a (mg/m^3)	1.924	19	0.270	2.400	1.000	1.070	1
Alk, total (mg/l)	55.0	22	18.0	56.0	34.5	21.8	27
Hard (mg/l)	50.0	21	20.0	56.0	34.0	21.3	31
CBOD-5 (mg/l)	2.5	14	0.2	5.3	0.9	1.5	9
COD (mg/L)	7.5	9	2.0	10.0	2.0	2.0	4
TSS (mg/l)	17.0	23	1.0	28.0	7.0	16.0	27
TDS (mg/l)	102.0	21	59.0	116.0	78.0	66.0	21
TOC (mg/l)	9.179	20	2.267	12.678	4.957	3.125	20
Total-P (mg/l)	0.073	22	0.020	0.106	0.050	0.050	34
NO2+NO3-N (mg/l)	0.158	23	0.003	0.229	0.060	0.158	33
NH3-N (mg/l)	0.058	23	0.015	0.079	0.015	0.033	33
TKN (mg/l)	0.629	22	0.150	0.726	0.335	0.278	32
DRP (mg/l)	0.025	23	0.004	0.029	0.011	0.017	15
AL-T (mg/l)	1.590	10	0.200	2.070	0.748	0.200	6
AL, Dis (mg/l)	0.200	10	0.100	0.200	0.200	0.108	2
Fe-T (mg/l)	1.820	10	0.358	2.170	1.109	0.981	12
Fe, Dis (mg/l)	0.482	10	0.123	0.507	0.324	0.241	2
Mn-T (mg/l)	0.082	3	0.058	0.087	0.062	0.124	12
Mn, Dis (mg/l)	0.050	4	0.042	0.050	0.048		0

Macroinvertebrate bioassessment sample collection and processing: Habitat and macroinvertebrate assessments were conducted at three locations on Buxahatchee Creek (BXHS-4, BXHS-3A, and BXHS-2). Station descriptions are provided in the Station Locations Table of the 2005 Buxahatchee Creek Database. Assessments were conducted May 12th, 2005 using ADEM's Standard Operating Procedures and Quality Assurance Manual, Volume II-Freshwater Macroinvertebrate Biological Assessment (ADEM 1999). Macroinvertebrate samples were also processed and identified in accordance with ADEM 1999.

Macroinvertebrate assessments: Macroinvertebrate bioassessments were based on ADEM's 2005 Ecoregional Guidelines (ADEM 2005) for Piedmont (45; BXHS-3A and BXHS-4) and Ridge and Valley (BXHS-2) streams. Description of metrics and criteria are provided in Tables 2-4.

Table 2. Interpretation of metrics

Metric	ADEM 2005	Description
Total taxa richness	X	Total number of taxa (genera or lowest taxonomic level) collected at a site. Generally decreases with decreasing water quality, but can increase at low levels of nutrient enrichment.
EPT taxa richness	X	EPT taxa richness is the total number of distinct taxa (genera) within the generally pollution-sensitive orders Ephemeroptera, Plecoptera, and Trichoptera. This metric generally increases with increasing water quality, but may also increase due to low-level organic enrichment.
% EPT organisms	X	Percent of organisms collected at a site that are members of the EPT orders (see above). Generally decreases with decreasing water quality; but can increase at low levels of nutrient enrichment.
NCBI	X	Index between 1 and 10 calculated by multiplying the number of organisms within a single taxon by the tolerance value of that taxon (also 1-10). ADEM's tolerance values are based on those developed by North Carolina (Lenat 1993), but calibrated to ADEM's method and level of taxonomic identification (ADEM 1999, ADEM 2005). The biotic index increases as water quality decreases.
% Dominant taxon	X	Percent contribution of the numerically dominant taxon. This metric generally increases with decreasing water quality.
% Nutrient-tolerant taxa		Percent contribution of 13 taxa generally found to be tolerant of nutrient enriched conditions, including *Baetis*, *Stenacron*, *Cheumatopsyche*, *Chironomus*, *Polypedilum*, *Rheotanytarsus*, *Cricotopus*, *Simulium*, *Psephenus*, *Stenelmis*, *Lirceus*, *Physella*, *Elimia*, Oligochaeta (Brumley et al. 2003). ADEM modified this metric by using percent contribution of the families Baetidae, Simuliidae, and Physidae. Percent nutrient tolerant taxa is generally 44% or lower at ADEM's ecoregional reference reaches.

Table 3. Scoring criteria for ADEM's Ridge and Valley (67) bioregion.

Bioregion 67				
Score	**0**	**1**	**3**	**5**
Total taxa richness	<28	28-55	56-65	>65
EPT taxa richness	<8	8-15	16-19	>19
% EPT organisms	<18	18-37	38-52	>52
NCBI	>7.65	5.30-7.65	4.50-5.30	<4.5
% Dominant taxon	>48	24-48	14-24	<14
Final Assessment	**Poor**	**Fair**	**Good**	**Excellent**
Final Score	<10	11-15	16-21	>21

Table 4. Scoring criteria for ADEM's Piedmont (45) bioregion.

Bioregion 45				
Score	**0**	**1**	**3**	**5**
Total taxa richness	<24	24-47	48-57	>58
EPT taxa richness	<7	7-13	14-18	>18
% EPT organisms	<14	14-27	28-37	>37
NCBI	>7.6	5.2-7.6	5.2-4.9	<4.9
% Dominant taxon	>65	33-65	22-32	13-22
Final Assessment	**Poor**	**Fair**	**Good**	**Excellent**
Final Score	<12	12-16	17-20	>20

Periphyton bioassessment sample collection and processing: Periphyton bioassessments were conducted at BXHS-4, BXHS-3A and BXHS-2. Station descriptions are provided in the Station Locations Table of the 2005 Buxahatchee Creek Database. Assessments were conducted using ADEM's 2005 Standard Operating Procedures and Quality Assurance Manual (ADEM 2005b). Rapid periphyton surveys (RPSs) were conducted at BXHS-2 and BXHS-3a on May 12th. Periphyton biomass as chlorophyll *a* and an RPS was collected at BXHS-4 during April, May, and October of 2005.

Periphyton assessments: Periphyton bioassessments of the bioassessments conducted in May were based on ADEM's 2002 Periphyton Bioassessment Guidelines (ADEM 2004). Description of metrics and criteria are provided in Table 5.

Table 5. Interpretation of periphyton metrics.

Metric	75th %ile of Ecoregional Reference Sites (ADEM 2004)	Description
Periphyton Biomass as Chlorophyll *a*	33	One of the four variables currently recommended to initiate nutrient criteria development (USEPA 2000). Measured as mg/m2 using standard methods. Generally increases with increasing nutrient enrichment. It can difficult to accurately measure in streams due to the patchy distribution, scouring, and occurrence on non-uniform stream bottoms. It is also possible to miss peak biomass.
% Cover Filamentous Algae	29	% of stream bottom covered with filamentous (nuisance) algae (visually estimated). Also subject to scouring.
Periphyton Thickness	0.8	Visual estimate of periphyton thickness in mm. Increases with increasing nutrient enrichment.

Results

Macroinvertebrate assessment results are summarized in Table 6. Periphyton assessment results are summarized in Table 7.

BXHS-2: Buxahatchee Creek at BXHS-2, located upstream of the Calera WWTP, drains the city of Calera. The stream reach was estimated to be 100% pool habitat. Flows and stream velocity were generally low. The site was characterized by sand (45%), gravel (25%), and silt (17%) substrates and a lack of riparian buffer.

The macroinvertebrate community at BXHS-2 appeared to be in worse condition than the downstream sites, with the highest NCBI value (8.0) and an EPT taxa richness score of 0. These results may be at least partly attributed to low flow and the lack of riffle-run habitat.

Periphyton bioassessment results indicated percent cover as filamentous algae and periphyton thickness to be higher than expected at ADEM's ecoregional reference reaches. However, these results may also be due in part to the slower velocities and lack of scouring at the site.

Median and average nutrient concentrations at the site were generally similar to the 90th percentile of nutrient concentrations at ADEM's ecoregional reference reaches in Ecoregion 67g. The chlorophyll *a* concentration in May was 9.08 mg/L in May, however, and median and average chlorophyll *a* values were higher than values expected at ADEM's reference reaches. Fecal coliform was measured at 3,200 colonies/100mL during a high-flow event in April.

BXHS-3: Buxahatchee Creek at BXHS-3 is located downstream of the Calera WWTP. The stream reach was characterized by 70% cobble substrate and 95% run habitat. The habitat assessment rated habitat quality as *good* using the riffle-run habitat assessment matrix.

A macroinvertebrate assessment was not conducted at the site.

Median and average nutrient concentrations at the site exceeded values expected at ADEM's reference reaches located in Ecoregion 67g. The dissolved oxygen concentration in July was measured at 4.3 mg/L. Flow was not measured during any of the site visits. Fecal coliform was measured at 2,800 colonies/100mL during a high-flow event in April. Total suspended solids, total dissolved solids, alkalinity, and hardness were also elevated at the site.

BXHS-3A: Buxahatchee Creek at BXHS-3A is located downstream of the Calera WWTP. The stream reach was dominated by run habitat with some riffle areas. Bottom substrates were composed of 43% sand and silt and 57% stable substrates. The habitat assessment rated habitat quality as *good* using the riffle-run habitat assessment matrix.

The macroinvertebrate community at BXHS-3A was assessed as *poor*, based on ADEM's 2005 Ecoregional Assessment Guidelines. Eighty percent of the organisms collected were classified as nutrient tolerant taxa, suggesting that nutrient enrichment is affecting the diversity and composition of the macroinvertebrate community. Conditions were improved from BXHS-2, however, due to increased flow and aeration of water through the riffle areas.

Periphyton bioassessment results also suggest nutrient enrichment. Filamentous algae was estimated to cover 65% and 43% of the stream bottom within the macroinvertebrate and periphyton bioassessment sampling reaches, respectively. Average periphyton thickness was 13.5mm.

Median and average nutrient concentrations at the site exceeded values expected at ADEM's reference reaches located in Ecoregion 45a. Flow was not measured during any of the site visits. Total dissolved solids, alkalinity, and hardness were also elevated at the site.

BXHS-4: Buxahatchee Creek at BXHS-4, the downstream-most site, was estimated to be 30% riffle and 40% run habitat. Bedrock (40%), sand (20%) boulder (15%), and cobble (15%) were the dominant substrate types. The habitat assessment rated habitat quality as *excellent* using the riffle-run habitat assessment matrix.

The macroinvertebrate community at BXHS-4 was improved from BXHS-2 and BXHS-3a, probably due to the improved habitat conditions. The macroinvertebrate community was assessed as *poor*, however, based on ADEM's 2005 Ecoregional Assessment Guidelines. Close to 65% of the organisms collected were classified as nutrient tolerant taxa.

Percent filamentous algal cover and periphyton biomass as chlorophyll a were similar to ecoregional reference conditions.

Median and average nutrient concentrations at the site exceeded values expected at ADEM's reference reaches located in Ecoregion 45a. Total dissolved solids, alkalinity, and hardness were also elevated at the site.

Table 6. Summary of macroinvertebrate assessment results.

Metric	BXHS-2	BXHS-3a	BXHS-4
Total Taxa Richness	33	36	39
EPT Taxa Richness	0	5	6
% EPT Organisms	0	21	30
% Dominant Taxon	32	22	26
NC Biotic Index	8.0	7.3	6.0
% Nutrient Tolerant	67	80	64
EPT Families	0	4	5

Assessment Score	2	7	8
Final Assessment	Poor	Poor	Poor

Table 7. Summary of periphyton assessment results.

Metric	75^{th} %ile of Ecoregional Reference Sites (ADEM 2004)	BXHS-2	BXHS-3a	BXHS-4
Sampling Date		5/12/2005	5/12/2005	5/11/2005
Periphyton Biomass as Chlorophyll a (mg/m^2)	33	---	---	41.9
% Cover Filamentous Algae	29	53	43	22
Average Periphyton Thickness (mm)	0.8	7.5	13.5	4.7

Conclusions

Macroinvertebrate assessment results indicated the macroinvertebrate communities above and below the Calera WWTP to be in *poor* condition. The poor conditions at BXHS-2 may be at least partly attributed to low flow and the lack of riffle-run habitat. Results of water quality sampling and periphyton bioassessments conducted during 2005 suggest that nutrient enrichment is also affecting the macroinvertebrate communities at BXHS-3a, and, to a lesser extent, BXHS-4.

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